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ABSTRACT

This competency-based curriculum guide contains materials for conducting a course in residential wiring. A technically revised edition of the 1978 publication, the guide includes 28 units. Each instructional unit includes some or all of the following basic components: performance objectives, suggested activities for teachers and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the tests. Units are planned for more than one lesson or class period of instruction. The units are grouped into eight sections covering the following general topics: orientation, tools, basic theory, using trade information, basic equipment and procedures. wiring residential circuits, existing dwellings, and related information, such as customer service, estimating, and applying for a job. Line drawings are used to illustrate the information. (KC)

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ED226150

Residential Wiring

By
Mark Taylor

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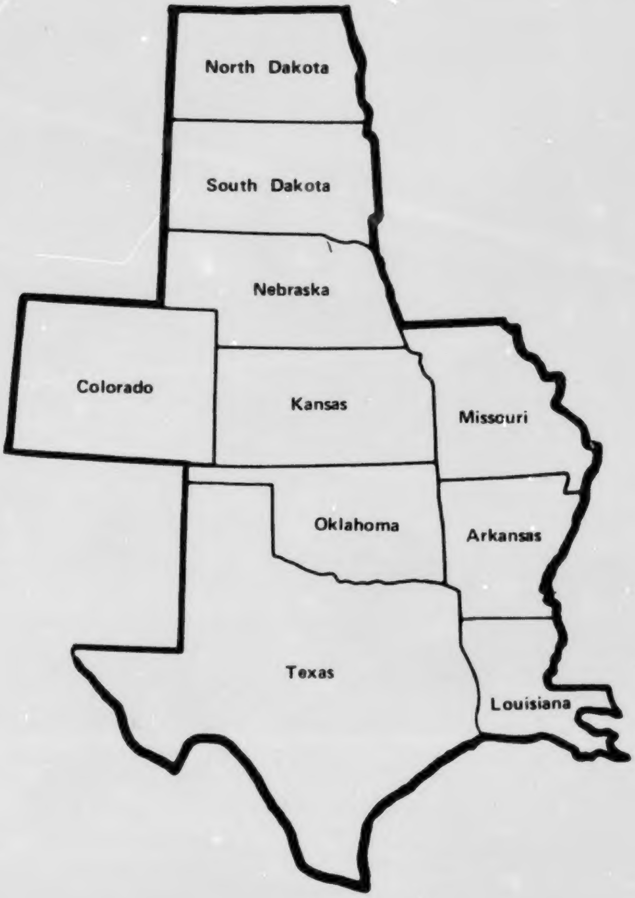
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FOREWORD

The Mid-America Vocational Curriculum Consortium (MAVCC) was organized for the purpose of developing instructional material for its member states. Priorities for developing MAVCC material are determined annually based on the needs as identified by all member states. One of the first priorities identified was wiring in residential applications.

Since this publication was released in 1978, it has met with tremendous acceptance. Both teachers and students throughout the country have used it as their basic text, and industry has found it to be an essential tool in their apprenticeship training. So that these users can continue to use *Residential Wiring* as one of the basic tools of their trade, it has been technically revised to meet the latest codes.

The success of this publication is due, in large part, to the capabilities of the personnel who worked with its development. The technical writer has numerous years of industry as well as teaching experience. Assisting him in his efforts were representatives of each of the member states who brought with them technical expertise and the experience related to the classroom and to the trade. To assure that the materials would parallel the industry environment and be accepted as a transportable basic teaching tool, organizations and industry representatives were involved in the developmental phases of the manual. Appreciation is extended to them for their valuable contributions to the manual.

This publication is designed to assist teachers in improving instruction. As this publication is used, it is hoped that the student performance will improve and that students will be better able to assume a role in their chosen occupation, residential wiring.

Instructional materials in this publication are written in terms of student performances using measurable objectives. This is an innovative approach to teaching that accents and augments the teaching/learning process. Criterion referenced evaluation instruments are provided for uniform measurement of student progress. In addition to evaluating recall information, teachers are encouraged to evaluate the other areas including process and product as indicated at the end of each instructional unit.

It is the sincere belief of the MAVCC personnel and all those members who served on the committees that this publication will allow students to become better prepared and more effective members of the work force.

David Poston, Chairman
Board of Directors
Mid-America Vocational Curriculum
Consortium

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PREFACE

For many years those responsible for teaching Residential Wiring have felt a need for instructional materials to use in this area. A team of teachers, industry representatives, and trade and industrial education staff members accepted this challenge and have produced a manual which will meet the needs of courses where students are expected to become proficient in the area of residential wiring.

Every effort has been made to make this publication basic, readable, and by all means usable. Three vital parts of instruction have been intentionally omitted from this publication: motivation, personalization, and localization. These areas are left to the individual instructors and the instructors should capitalize on them. Only then will this publication really become a vital part of the teaching-learning process.

In addition, we would appreciate your help. We check for content quality, spelling, and typographical errors many times in the development of a manual. It is still possible, however, for an error to show up in publication.

If, in the use of this publication, you should find something questionable we would appreciate you bringing it to our attention. A copy of the page or pages in question with your suggestions for correction would certainly help us when we revise and update materials.

We're trying to provide you with the best possible curriculum materials and will certainly appreciate your help in detecting areas where possible corrections are needed to maintain the quality you want and deserve.

Ann Benson
Executive Director
Mid-America Vocational Curriculum
Consortium, Inc.

ACKNOWLEDGMENTS

Appreciation is extended to those individuals who contributed their time and talents in the development of Residential Wiring.

The contents of this publication were planned and reviewed by:

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Special thanks are extended to Mel Winegarten, Director, Electrical Joint Apprenticeship and Training Committee, Tulsa Oklahoma. His professional expertise contributed much to this publication.

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Gratitude is expressed to Regina Decker for editing and to the Graphics Division of Oklahoma State Department of Vocational and Technical Education for typing.

Special appreciation is extended to Bill Stites, Alva Oklahoma. His guidance and direction is present in all parts of this publication.

The printing staff of the Oklahoma State Department of Vocational and Technical Education are deserving of much credit for printing this publication.

USE OF THIS PUBLICATION

Instructional Units

The *Residential Wiring* curriculum includes 28 units. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for teachers and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the test. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help to determine:

A. The amount of material that can be covered in each class period
B. The skills which must be demonstrated
    1. Supplies needed
    2. Equipment needed
    3. Amount of practice needed
    4. Amount of class time needed for demonstrations
C. Supplementary materials such as pamphlets or filmstrips that must be ordered
D. Resource people who must be contacted

Objectives

Each unit of instruction is based on performance objectives. These objectives state the goals of the course, thus providing a sense of direction and accomplishment for the student.

Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Following is a list of performance terms and their synonyms which may have been used in this material:

Name	Identify	Describe
Label	Select	Define
List in writing	Mark	Discuss in writing
List orally	Point out	Discuss orally
Letter	Pick out	Interpret
Record	Choose	Tell how
Repeat	Locate	Tell what
Give		Explain

Information Sheets

Information sheets provide content essential for meeting the cognitive (knowledge) objectives in the unit. The teacher will find that the information sheets serve as an excellent guide for presenting the background knowledge necessary to develop the skill specified in the unit objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion. (NOTE: Stand away from the overhead projector when discussing transparency material. The noise of the projector may cause the teacher to speak too loudly.)

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledges which are necessary prerequisites to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to and in most situations should demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for students to follow if they have missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances which might reasonably be expectd from a person who has had this training.

Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teacher should be constructed and added to the test.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

RESIDENTIAL WIRING

INSTRUCTIONAL ANALYSIS

Job Training: What the Worker Should Be Able to Do (Psychomotor)	Related Information: What the Worker Should Know (Cognitive)

SECTION A--ORIENTATION

UNIT I: OCCUPATIONAL INTRODUCTION

1. Terms
2. Job responsibilities
3. Occupational hazards
4. Learner characteristics
5. Undesirable working situations
6. Occupational outlook
7. Employment possibilities

UNIT II: GENERAL SAFETY

1. Terms
2. Federal safety color code
3. Rules for personal safety
4. Dangerous shop conditions
5. Accident prevention
6. Shop organization
7. Classification of fires
8. Fire extinguishers
9. Fire triangle
10. Safety pledge

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)

UNIT III: ELECTRICAL SAFETY

JOB TRAINING	RELATED INFORMATION
	1. Terms
	2. Safety signs or tags
	3. Causes of accidents
	4. Safety practices
	5. Fire prevention
	6. Ladder safety
	7. Hand tool safety
	8. Electric hand tool safety
	9. Dress
	10. Lifting techniques
	11. Third wire
	12. GFI
	13. Live circuit safety
	14. Rescue procedures
	15. Current effects on body

SECTION B--TOOLS

UNIT I: POUCH TOOLS

JOB TRAINING	RELATED INFORMATION
	1. Tools
	2. Common tool uses
	3. Tool selection
	4. Maintenance procedure for pouch tools
5. Clean and lubricate pliers	
6. Grind a flat blade screwdriver	
7. Adjust wire strippers	

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JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)

UNIT II: SPECIALTY TOOLS

1. Specialty tools
2. Specialty tool uses
3. Care of tools
4. Solder a joint with an iron
5. Set up and use a hacksaw
6. Use a knockout punch
7. Use a volt ohmmeter
8. Use a clamp on ammeter

SECTION C--BASIC THEORY

UNIT I: OHM'S LAW

1. Terms
2. Letter designations from formula
3. Ohm's law
4. Uses of Ohm's law
5. Formulas
6. Power equation
7. Uses of power equation
8. Formulas
9. Solve problems

UNIT II: BASIC THEORY

1. Terms
2. Schematic symbols
3. Alternating current
4. Diagrams and schematics
5. Series circuits

JOB TRAINING: What the Worker Should Be Able to Do
(Psychomotor)

RELATED INFORMATION: What the Worker Should Know
(Cognitive)

6. Rules for series circuits
7. Application for series circuits
8. Parallel circuits
9. Rules for parallel circuits
10. Applications for parallel circuits

UNIT III: CONDUCTORS, CABLES AND CORDS

1. Terms
2. Type letter designations
3. Sizes of conductors
4. Common conductors
5. Installation conditions for insulations
6. Common cables
7. Cable uses
8. Cords and cables

SECTION D--USING TRADE INFORMATION

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1. Writing procedure
2. Purpose
3. Chapter arrangement
4. General facts
5. Cross reference system
6. Answer code question
7. Use tables

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)

UNIT II: BLUEPRINTS AND SPECIFICATIONS

1. Terms
2. Symbols for blueprints
3. Electrical symbols
4. Types of lines
5. Specifications
6. Reading a rule
7. Measure objects

SECTION E--BASIC EQUIPMENT AND PROCEDURES

UNIT I: EQUIPMENT

1. Boxes
2. Box features
3. Devices
4. Covers and plates
5. Supports and anchors
6. Screws, bolts, nuts and nails
7. Connectors, terminals, and lugs
8. Factors for selecting connectors, terminals, and lugs

UNIT II: WIRING METHODS

1. Terms
2. Types of methods
3. Applications of methods
4. Install a set screw connector
5. Install a liquid tight connector
6. Braid an S.E. cable neutral

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)

UNIT III: LOAD CENTERS

1. Terms
2. Types of safety switch enclosures
3. Load center accessories
4. Possible installations
5. Parts of fusible load center
6. Parts of breaker load center
7. Safety rules
8. Panel configurations

SECTION F--WIRING RESIDENTIAL CIRCUITS

UNIT I: OVERCURRENT PROTECTION

1. Terms
2. Types of overcurrent devices
3. Single element fuse operation
4. Time delay fuse operation
5. Circuit breaker operation
6. Code requirements for fuses
7. Code requirements for breakers
8. GFI locations

UNIT II: NEW CONSTRUCTION BOX LOCATION PLANNING AND INSTALLATION

1. Terms
2. Required locations for receptacles
3. Planning techniques
4. Box heights
5. Boxes in brick veneer

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
	6. Box set out
	7. Room centers
	8. Locating devices on floor line
	9. Locating devices along counterspace
10. Install boxes along counters	
11. Install ceiling boxes	

UNIT III: SWITCHING SITUATIONS

	1. Terms
	2. Box size
	3. Terminal identification
	4. Grounding boxes
	5. Parts of switching circuits
	6. Calculate box size
7. Wire single pole switching circuits	
8. Wire a three way switching circuit	
9. Wire a four way switching circuit	

UNIT IV: RECEPTACLE OUTLETS

	1. Terms
	2. Common receptacles
	3. Parts of a duplex grounding receptacle
	4. Parts of grounding circuit
	5. NEC requirements for receptacles

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
6. Install a duplex grounding type receptacle	
7. Install a range or dryer receptacle	
8. Install a multi-circuit split-wired duplex grounding type receptacle	
UNIT V: COMBINATION CIRCUITS	
	1. Terms
	2. Rules for installations
	3. Governing agencies
4. Wire a split-wired receptacle	
5. Wire a receptacle through a lighting outlet	
6. Feed a receptacle through a three way	
UNIT VI: LOW VOLTAGE WIRING	
	1. Terms
	2. Low voltage lighting system components
	3. Low voitage operating cycle
	4. Chime circuit
	5. Thermostat manual fan switching cycle
	6. Cool system switch
	7. Heat position
	8. Anticipation circuits
9. Wire a two switch low voltage system	
10. Wire a two button chime circuit	

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELEATED INFORMATION: What the Worker Should Know (Cognitive)
11. Measure heat anticipator current draw	
12. Install a wall thermostat	

UNIT VII: RESIDENTIAL SERVICE INSTALLATIONS

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELEATED INFORMATION: What the Worker Should Know (Cognitive)
	1. Terms
	2. Drop clearances
	3. Equipment size
	4. Service disconnects
	5. Facts before starting service installation
	6. Parts of a service entrance
	7. Types of grounding electrodes
	8. Grounding electrode conductors
	9. Calculate service needed size
10. Install an overhead raceway with service entrance conductors to a meter base	
11. Connect meter base assembly to load center or panel	

UNIT VIII: TRIM OUT

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELEATED INFORMATION: What the Worker Should Know (Cognitive)
	1. Terms
	2. Appliance classification
	3. Disconnecting means for appliances
	4. Grounding
	5. Connecting appliances
6. Connect a supply cord to a garbage disposal	
7. Connect a supply cord to a free standing range	

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
8. Connect a fixed appliance equiped with a pigtail to a branch circuit	
9. Install plates on devices	

SECTION G--EXISTING DWELLINGS

UNIT I: BOX INSTALLATIONS

JOB TRAINING	RELATED INFORMATION
	1. Terms
	2. Wall coverings
3. Install a box in a plasterboard wall	
4. Secure a box with drywall supports	
5. Install a box in a lath and plaster wall	
6. Install a box in a paneled wall	
7. Install a box in a concrete block wall	
8. Install a box in a brick wall	
9. Install a box in a ceiling with an accessible attic	

UNIT II: CABLE INSTALLATIONS

JOB TRAINING	RELATED INFORMATION
	1. Terms
	2. Construction members
	3. Cable routes
4. Install a cable between an existing box horizontally along a wall in a channel behind a baseboard	
5. Install a cable between an existing box and a newly installed box using an underfloor crawl space	

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
6. Install a cable between an existing box and newly installed box using attic space	

UNIT III: LOAD CENTER CHANGES

JOB TRAINING	RELATED INFORMATION
	1. Terms
	2. Service capacity increases
	3. Changing a service
4. Replace an existing interior flush mount load center	
5. Install a rainproof load center to feed an existing panel as a sub	
6. Install a fusible safety switch for an air conditioning condensor	

SECTION H--RELATED INFORMATION

UNIT I: TROUBLESHOOTING

JOB TRAINING	RELATED INFORMATION
	1. Terms
	2. Safe operating equipment
	3. Basic troubleshooting procedures
	4. Importance of troubleshooting
5. Troubleshoot an electrical system problem	

UNIT II: CUSTOMER SERVICE

JOB TRAINING	RELATED INFORMATION
	1. Terms
	2. Personality traits
	3. Customer differences
	4. Phone conversations
	5. Customer expectations
	6. Legal problems

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
UNIT III: TAKE OFF AND ESTIMATE	
	1. Terms
	2. Estimating methods
	3. Residential bids
	4. Pricing
	5. Determine materials needed for installing a service
	6. Calculate material for appliance circuits
	7. Calculate materials for general purpose branch circuits
UNIT IV: APPLYING FOR A JOB	
	1. Terms
	2. Locating openings
	3. Methods of applying
	4. Application form items
	5. Attitudes
	6. Interview conduct
	7. Prepare a resume
	8. Fill out an application
	9. Write a follow up letter for an interview

MASTER TOOL LIST

Pouch Tools

- Folding rule with sliding scale or tape measure
- Tap tool
- Adjustable wrench
- Flat blade screwdrivers
  - 3/16 x 6"
  - 5/16 x 6"
- Phillips head screwdriver #2 x 4"
- Stubby screwdrivers
  - Phillips head #2 x 1 1/2"
  - Flat blade 1/4" x 1 1/2"
- Wire strippers
- Long nose pliers (needle nose)
- Lineman's pliers (side cutters) 9"
- Diagonal pliers
- Groove joint pliers
- Pocket knife (locking blade)
- Electrician's hammer
- Neon test light
- Awl
- Electrician's tool pouch

Specialty tools

- Soldering iron or gun
- Hacksaw
- Brace
- 1/4" Drillmotor
- 1/2" Drillmotor
- Knockout punch set
- Keyhole saw
- Fish tape and rell
- Drop chain
- Reciprocal saw
- Volt ohmmeter
- Hickey benders:
  - 1/2"
  - 1/3/4"
  - 1"
- Torpedo level
- Plumb bob
- EMT benders:
  - 1/2"
  - 3/4"
  - 1"
- File assortment
- Chisel assortment
- Ship auger bits
  - Brace bits:
    - 1/4"
    - 3/8"
    - 1/2"
    - 5/8"

- Bit extensions:
  - 12"
  - 24"
- Drill motor bits:
  - 1/4"
  - 3/8"
  - 1/2"
  - 5/8"
  - 3/4"
  - 1"
- Twist drill bit set
- Masonry bit set
- Pipe reamer

Other tool room and shop tools

- Conduit vise
- Concrete chisel set
- Conduit threading set
- Extension cords (Round 3-wire 12 gauge):
  - 25'
  - 50'
  - 100'
- Portable ground fault interupter
- Safety glasses
- Bench grinder with shields and mask
- 3/8" socket set
- 1/2" socket set
- Combination wrench set
- Allen set
- Wire brush
- Pipe wrenches:
  - 8"
  - 10"
  - 12"
- Fire extinguisher
- Circular saw
- Wood stepladders (heavy duty):
  - 5'
  - 6'
  - 8'
  - 12'
- Wood extension ladder 24'
- Hard hat
- Plastic anchor kit
- 5 lb. shop hammer
- Ground rod driver

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(NOTE: This is an alphabetized list of the publications used in completing this manual.)

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OCCUPATIONAL INTRODUCTION
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to list job responsibilities, facts about the occupational outlook, desirable student qualities and employment possibilities. The student should also be able to discuss the occupational hazards. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define terms associated with the occupational introduction to residential wiring.
2. List job responsibilities of residential electricians.
3. Discuss occupational hazards of residential electricians.
4. Select required characteristics for a student in a residential wiring program.
5. List four undesirable working situations for residential electricians.
6. List four facts concerning the occupational outlook for residential electricians.
7. List three employment possibilities for a student in a residential wiring program.

OCCUPATIONAL INTRODUCTION
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information sheet.

  C. Discuss unit and specific objectives.

  D. Discuss information sheet.

  E. Discuss the working conditions of the residential electrician.

  F. Invite local contractor in to talk to class.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Participate in class discussion about working conditions of the residential electricians.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Test

  D. Answers to test

II. Reference--*Electricity Occupations Curriculum Guide.* Springfield, Illinois: Division of Vocational and Technical Education/Illinois Office of Education, July 1975.

OCCUPATIONAL INTRODUCTION
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Residential electrician and apprentice--Electrical wirer who installs all the wiring required in a residence after the utility company's final connection

      (NOTE: Local electrical codes prevail in all installations.)

   B. Electrical contractor--Person in electrical wiring field who is licensed to perform electrical work and who is legally capable of entering into contractual agreements with other parties

      (NOTE: The electrical contractor usually works under strict licensing, bonding, and insurance requirements.)

   C. Occupation--The vocation or activity at which a person works

II. Job responsibilities of residential electricians

   A. Install all types of electrical equipment

   B. Hang electrical fixtures

   C. Set and mount electrical appliances

   D. Troubleshoot defective systems

   E. Effectively communicate with customers

III. Occupational hazards

   A. Death--Careless and unsafe work habits can result in fatal accidents

   B. Burns--Accidental shorts or faults occasionally blow slag or molten metal which can burn

   C. Broken bones or bruises--Working on ladders or in other hazardous construction situations can result in falls

   D. Sprains or muscle tear--Many pieces of electrical equipment are heavy and bulky, and help must be summoned often to avoid injury to one person

INFORMATION SHEET

IV. Required characteristics for a student in a residential wiring program

A. Is safety conscious and follows all safety regulations

B. Takes instructions readily

C. Follows directions

D. Controls temper at all times

E. Works with enthusiasm

F. Exhibits pride in the electrical profession

G. Practices conservation of materials and man-hours

H. Is punctual

I. Operates all equipment correctly

J. Must be mobile

K. Willing to work with others

V. Undesirable working situations

(NOTE: Residential electricians are highly respected trades workers. The jobs they perform are often in surroundings more desireable than those of other trades workers, but they still have situations arise that are demanding and difficult to work in.)

A. In attics

(NOTE: Air conditioners are wired during the hottest months of the year. Attic temperatures can easily reach 125° F.)

B. Under houses

C. In the weather

(NOTE: Quite often outages are caused by extreme weather changes such as ice build-up or heavy rains.)

D. At night

INFORMATION SHEET

VI. Occupational outlook

- A. Work available due to increased use of electrical appliances
- B. Total electric homes are becoming more popular
- C. Steady employment opportunities from retirement of present residential electricians
- D. Good opportunity for self-employment

VII. Employment possibilities

- A. Residential electrician under a contractor
- B. Salesperson in an electrical supply house
- C. Independent electrical contractor

OCCUPATIONAL INTRODUCTION
UNIT I

NAME ____________________

TEST

1. Define terms associated with the occupational introduction to residential wiring.

    a. Residential electrician and apprentice--

    b. Electrical contractor--

    c. Occupation-

2. List three job responsibilities of residential electricians.

    a.

    b.

    c.

3. Discuss occupational hazards of residential electricians.

4. Select required characteristics for a student in a residential wiring program by placing an "X" in the appropriate blanks.

_____a. Is safety conscious and follows all safety regulations

_____b. Takes instruction readily

_____c. Follows directions

_____d. Controls temper at all times

_____e. Works with enthusiasm

_____f. Exhibits pride in the electrical profession

_____g. Is over 6 feet tall

_____h. Practices conservation of materials and man-hours

_____i. Is punctual

_____j. Operates all equipment correctly

_____k. Must be mobile

_____l. Willing to work with others

5. List four undersirable working situations for residential electricians.

a.

b.

c.

d.

6. List four facts concerning the occupational outlook for residential wiring.

a.

b.

c.

d.

7. List three employment possibilities for a student in a residential wiring program

a.

b.

c.

OCCUPATIONAL INTRODUCTION
UNIT I

ANSWERS TO TEST

1.
    a. Residential electrician and apprentice--Electrical wirer who installs all the wiring required in a residence after the utility company's final connection
    b. Electrical contractor--Person in electrical wiring field who is licensed to perform electrical work and who is legally capable of entering into contractual agreements with other parties
    c. Occupation--The vocation or activity at which a person works
2. Any three of the following:
    a. Install all types of electrical equipment
    b. Hang electrical fixtures
    c. Set and mount electrical appliances
    d. Troubleshoot defective systems
    e. Effectively communicate with customers
3. Discussion should include:
    a. Death--Careless and unsafe work habits can result in fatal accidents
    b. Burns--Accidental shorts or faults occasionally blow slag or molten metal which can burn
    c. Broken bones or bruises--Working on ladders or in other hazardous construction situations can result in falls
    d. Sprains or muscle tear--Many pieces of electrical equipment are heavy and bulky, and help must be summoned often to avoid injury to one person
4. a, b, c, d, e, f, h, i, j, k, l
5.
    a. In attics
    b. Under houses
    c. In the weather
    d. At night

6. a. Work available due to increased use of electrical appliances
   b. Total electric homes are becoming more popular
   c. Steady employment opportunities from retirement of present residential electricians
   d. Good opportunity for self-employment

7. a. Residential electrician under a contractor
   b. Salesperson in an electrical supply house
   c. Independent electrical contractor

GENERAL SAFETY
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to define terms related to safety, recognize unsafe situations, and be able to state rules for shop and personal safety. The student should be able to select the correct fire extinguisher for the classes of fire and match the safety color code with statements of its use. The student should also be willing to sign the safety pledge form. This knowledge will be evidenced through demonstration and by scoring one-hundred percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define terms associated with general safety.
2. Match the six colors of the federal safety color code with statements of their use.
3. List personal safety rules.
4. List three shop conditions that should be reported to the instructor.
5. List general shop rules for preventing accidents.
6. List steps in maintaining a clean and orderly shop.
7. Match the four classes of fires with statements defining each class.
8. Select from a list of fire extinguishers the types best suited to extinguish each class of fire.
9. List the three components of the fire triangle.
10. Indicate a willingness to work safely by subscribing to the student safety pledge form.

GENERAL SAFETY
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information sheet and the safety pledge form.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. H[illegible]ire drill.

   G. Have a fire department representative give a class presentation.

   H. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete the safety pledge form.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Types of Fire Extinguishers

      2. TM 2--The Fire Triangle

D. Assignment Sheet #1--Subscribe to the Student Safety Pledge Form

E. Test

F. Answers to test

II. References:

A. *The ABC's of Fire Protection.* Belleville, New Jersey: Kidde Portable Extinguishers, Walter Kidde and Company, Inc.

B. *An Accident Prevention Program for School Shops and Laboratories.* U.S. Department of Health, Education, and Welfare/Office of Education.

C. *Federal Register.* Department of Labor, Vol. 36. Number 105. Part II. May 29, 1971.

D. *Safety Practices and Procedures in School Shops.* Department of Education/Division of Vocational Education, State of New Jersey, 1968.

E. *Hobart General Welding Safety Rules.* Troy, Ohio: Hobart Arc Welding.

GENERAL SAFETY
UNIT II

INFORMATION SHEET

I. Terms and definitions

   A. Safety--State or condition of being safe; freedom from danger, risk, or injury

   B. Accident--Includes any suddenly occurring, unintentional event which causes injury or property damage

   C. First aid--Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained

II. Colors and application of the safety color code

   A. Federal safety red--Basic color for the identification of

      1. Fire protection equipment and apparatus

      2. Portable containers of flammable liquids

      3. Emergency stop bars, stop buttons, and emergency electrical stop switches on machinery

   B. Federal safety yellow--Basic color for designating

      1. Caution and for marking physical hazards

      2. Waste containers for explosive or combustible materials

      3. Caution against starting, using, or moving equipment under repair

      4. Identification of the starting point or power source of machinery

   C. Federal safety orange--Basic color for designating

      1. Dangerous parts of machines

      2. Safety starter buttons and parts of equipment that may produce electrical shock

      3. The exposed parts (edges only) of pulleys, gears, rollers, cutting devices, and power jaws

INFORMATION SHEET

- D. Federal safety purple--Basic color for designating radiation hazards
- E. Federal safety green--Basic color for designating
  - 1. Safety
  - 2. Location of first aid equipment

    (NOTE: This applies to equipment other than fire fighting equipment.)
- F. Federal safety black and white--Basic colors for designating

  (NOTE: These are used individually or in combination.)
  - 1. Traffic flow
  - 2. Housekeeping purposes

III. Personal safety rules

- A. Wear shop clothing appropriate to the instructional activity being performed
- B. Confine long hair before operating rotating equipment
- C. Always wear safety glasses
- D. Remove ties when working around machine tools or rotating equipment
- E. Remove rings and other jewelry when working in the shop
- F. Conduct yourself in a manner conducive to safe shop practices
- G. Use soap and water frequently as a method of preventing skin diseases
- H. Use suitable helmets and goggles for welding

IV. Conditions that should be reported

- A. Defects on equipment
- B. Any condition that can lead to an accident
- C. All accidents

INFORMATION SHEET

V. General shop rules

   A. Keep all hand tools sharp, clean, and in safe working order

   B. Retain all guards and safety devices except with the specific authorization of the instructor

   C. Operate a hazardous machine only after receiving instruction on how to operate the machine safely in all working conditions

   D. Turn off the power before leaving a machine tool

   E. Make sure all guards and barriers are in place and adjusted properly before starting a machine tool

   F. Disconnect the power from machine tools before performing the maintenance task of oiling or cleaning

   G. Use a solvent only after determining its properties, what kind of work it has to do, and how to use it

   H. Use correct, properly fitting wrenches for nuts, bolts, and objects to be turned or held

   I. Keep the shop or laboratory floor clear of scraps and litter

   J. Clean up any spilled liquids immediately

   K. Store oily rags or oily waste in metal containers

   L. Clean the chips from a machine with a brush--not with a rag or bare hands

   M. Wear eye protection when using grinders and buffers

   N. Do not work overtime in the shop unless instructor is present

   O. Consider the safety of others

   P. Do not throw objects while in the shop

   Q. Wear gloves when handling equipment and materials with sharp edges

   R. Do not distract people operating machines

   S. Check all equipment before activating

   T. Work with adequate light

   U. Do not run over cords with dollies or carts

INFORMATION SHEET

VI. Steps in maintaining a clean and orderly shop

A. Machinery and equipment arranged to permit safe efficient work practices and ease in cleaning

B. Materials and supplies safely stacked or stored in proper place

C. Tools and accessories safely stored in cabinets, on racks, or other suitable devices

D. Working areas and work benches clear and free of debris and other hazards

E. Floors clean and free from obstructions and slippery substances

F. Aisles, traffic areas, and exits free of materials and other debris

G. Combustible materials properly disposed of or stored in approved containers

H. Oily rags stored in self-closing or spring-lid metal containers

I. Sufficient brooms, brushes, and other housekeeping equipment readily available

VII. Classes of fires

A. Class A--Fires that occur in ordinary combustible materials, such as wood, rags, and rubbish

B. Class B--Fires that occur with flammable liquids, such as gasoline, oil, grease, paints, and thinners

C. Class C--Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring

D. Class D--Fires that occur with combustible metals such as magnesium

VIII. Types of fire extinguishers (Transparency 1)

A. Pressurized water--Operates usually by squeezing a handle or trigger; used on Class A fires

B. Soda acid--Operates by turning extinguisher upside down ; used on Class A fires

INFORMATION SHEET

C. Carbon dioxide (CO_2)--Operates usually by squeezing handle or trigger; used on Class B and C fires

D. Dry chemical--Operates usually by squeezing a handle, trigger, or lever; used on Class B, C, and D fires

(NOTE: On Class D fires, dry sand is as effective as any dry chemical other than Purple X. The cost of the Purple X chemical places it out of reach of most shops.)

E. Foam--Operates by turning extinguisher upside down; used on Class A and B fires

IX. Components of the fire triangle (Transparency 2)

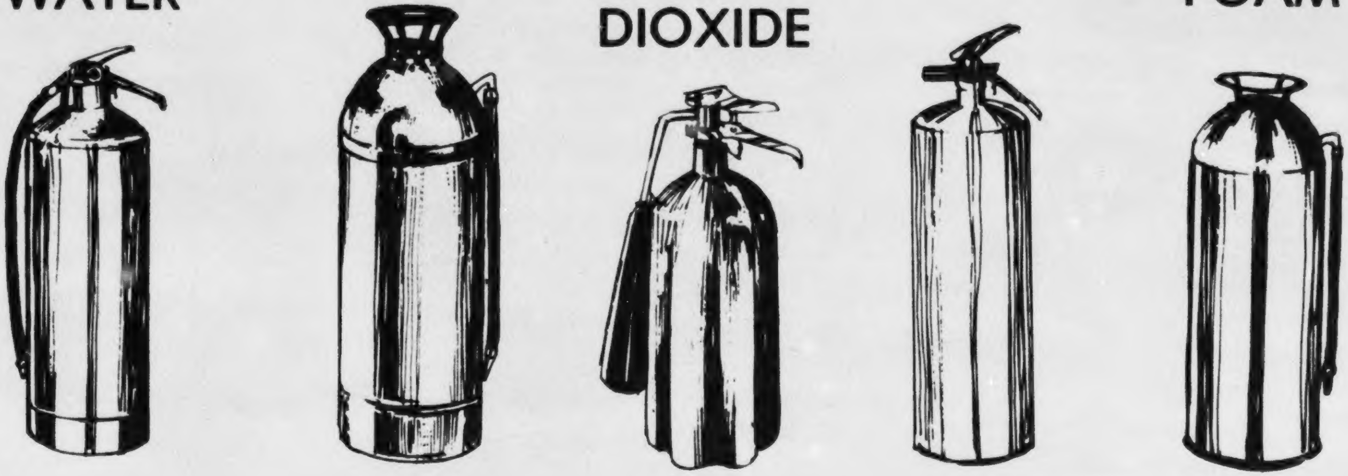
A. Fuel--Any combustible material

B. Heat--Enough to raise the fuel to its ignition temperature

C. Oxygen--Necessary to sustain combustion

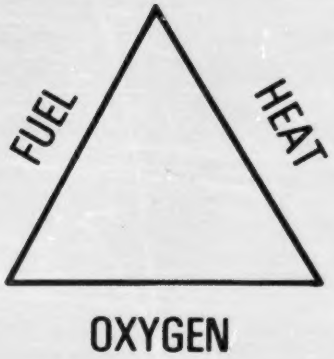
(NOTE If any one of the three is missing, a fire cannot be started or, with the removal of any one of them, the fire will be extinguished.)

Types of Fire Extinguishers

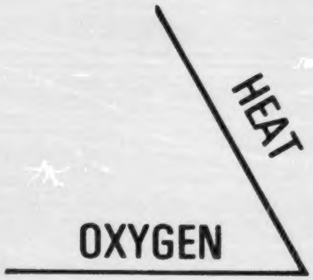

PRESSURIZED WATER
SODA-ACID
CARBON DIOXIDE
DRY CHEMICAL
FOAM

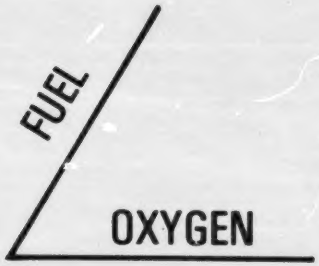
The Fire Triangle

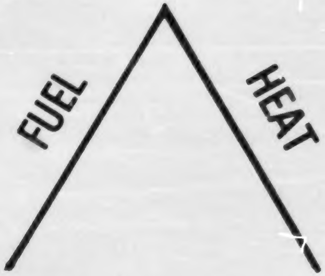
To produce fire, three things must be present at the same time.


FUEL
HEAT
OXYGEN

If any one of the three is missing, a fire cannot be started or, with the removal of any one, the fire will be extinguished.


HEAT
OXYGEN


FUEL
OXYGEN



GENERAL SAFETY
UNIT III

ASSIGNMENT SHEET #1--SUBSCRIBE TO THE STUDENT SAFETY PLEDGE FORM

________________________________, who is enrolled in Vocational __________ __________, will as part of his shop experience, operate machines, providing that the parent or guardian gives written permission.

It is important that each student will be given proper instruction, both in the use of the equipment and in correct safety procedures concerning it, before being allowed to operate it. The student must assume responsibility for following safe practices, and we therefore ask that the student subscribe to the following safety pledge.

1. I promise to follow all safety rules for the shop.
2. I promise never to use a machine without first having permission from the instructor.
3. I will not ask permission to use a particular machine unless I have been instructed in its use, and have made 100% on the safety test for that machine.
4. I will report any accident or injury to the teacher immediately.

Date__________Student's signature________________________________

I hereby give my consent to allow my son or daughter to operate all machines and equipment necessary in carrying out the requirements of the course in which he or she is enrolled.

Date__________Parent's signature________________________________

Parents are cordially invited to visit the shop to inspect the machines and to see them in operation.

GENERAL SAFETY
UNIT II

NAME ____________________

TEST

1. Define the following terms.

   a. Safety--

   b. Accident--

   c. First aid--

2. Match the following colors of the safety color code with the correct statements of their use.

   _____a. Designates caution and for marking physical hazards, waste containers for explosive or combustible materials, caution against starting, using, or moving equipment under repair, identification of the starting point or power source of machinery

   _____b. Identifies fire protection equipment and apparatus, portable containers of flammable liquids, emergency stop bars, stop buttons, and emergency electrical stop switches on machinery

   _____c. Designates safety and the location of first aid equipment

   _____d. Designates dangerous parts of machines, safety starter buttons, parts of equipment that may produce electrical shock, and the exposed parts (edges only) of pulleys, gears, rollers, cutting devices, and power jaws

   _____e. Designates traffic flow, housekeeping purposes

   _____f. Designates radiation hazards

   1. Federal safety green
   2. Federal safety white and black
   3. Federal safety orange
   4. Federal safety purple
   5. Federal safety red
   6. Federal safety yellow

3. List six personal safety rules.

   a.

   b.

   c.

   d.

   e.

   f.

4. List three shop conditions that should be reported to the instructor.

   a.

   b.

   c.

5. List ten general shop rules for preventing accidents.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

   h.

   i.

   j.

6. List five steps in maintaining a clean and orderly shop.

   a.

   b.

   c.

   d.

   e.

7. Match the classes of fire with the correct statement defining each class.

_____a. Fires that occur with flammable liquids such as gasoline, oil, grease, paints, or thinners

_____b. Fires that occur in ordinary combustible materials such as wood, rags, and rubbish

_____c. Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring

_____d. Fires that occur with combustible metals such as magnesium

1. Class A
2. Class B
3. Class C
4. Class D

8. Select the number or numbers of the fire extinguisher best suited to extinguish each class of fire.

_____a. Fires that occur with flammable liquids such as gasoline, oil, or grease

_____b. Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring

_____c. Fires that occur in ordinary combustible materials such as wood, rags, and rubbish

_____d. Fires that occur with combustible metals such as magnesium

1. Pressurized water
2. Carbon dioxide (CO_2)
3. Dry chemical
4. Soda acid
5. Foam

9. List the three components of the fire triangle.

a.

b.

c.

10. Indicate a willingness to work safely by subscribing to the student safety pledge form.

(NOTE: If this activity has not been accomplished prior to the test ask your instructor when it should be completed.)

GENERAL SAFETY
UNIT II

ANSWERS TO TEST

1. a. State or condition of being safe; freedom from danger, risk, or injury

   b. Includes any suddenly occuring, unintentional event which causes injury or property damage

   c. Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained

2. a. 6

   b. 5

   c. 1

   d. 3

   e. 2

   f. 4

3. Any six of the following:

   a. Wear shop clothing appropriate to the instructional activity being performed

   b. Confine long hair before operating rotating equipment

   c. Always wear safety glasses

   d. Remove ties when working around machine tools or rotating equipment

   e. Remove rings and other jewelry when working in the shop

   f. Conduct yourself in a manner conducive to safe shop practices

   g. Use soap and water frequently as a method of preventing skin diseases

   h. Use suitable helmets and goggles for welding

4. a. Defects on equipment

   b. Any condition that can lead to an accident

   c. All accidents

5. Any ten of the following:

   a. Keep all hand tools sharp, clean, and in safe working order

   b. Retain all guards and safety devices except with the specific authorization of the instructor

   c. Operate a hazardous machine only after receiving instruction on how to operate the machine safely in all working conditions.

   d. Turn off the power before leaving a machine tool

   e. Make sure all guards and barriers are in place and adjusted properly before starting a machine tool

   f. Disconnect the power from machine tools before performing the maintenance task of oiling or cleaning

   g. Use a solvent only after determining its properties, what kind of work it has to do, and how to use it

   h. Use correct, properly fitting wrenches for nuts, bolts, and objects to be turned or held

   i. Keep the shop or laboratory floor clear of scraps and litter

   j. Clean up any spilled liquids immediately

   k. Store oily rags or oily waste in metal containers

   l. Clean the chips from a machine with a brush--not with a rag or bare hands

   m. Wear eye protection when using grinders and buffers

   n. Do not work overtime in the shop unless instructor is present

   o. Consider the safety of others

   p. Do not throw objects while in the shop

   q. Wear gloves when handling equipment and materials with sharp edges

   r. Do not distract people operating machines

   s. Check all equipment before activating

   t. Work with adequate light

   u. Do not run over cords with dollies or carts

6. Any five of the following:
   - a. Machinery and equipment arranged to permit safe efficient work practices and ease in cleaning
   - b. Materials and supplies safely stacked or stored in proper place
   - c. Tools and accessories safely stored in cabinets, on racks, or other suitable devices
   - d. Working areas and work benches clear and free of debris and other hazards
   - e. Floors clean and free from obstructions and slippery substances
   - f. Aisles, traffic areas, and exits free of materials and other debris
   - g. Combustible materials properly disposed of or stored in approved containers
   - h. Oily rags stored in self-closing or spring-lid metal containers
   - i. Sufficient brooms, brushes, and other housekeeping equipment readily available
7.
   - a. 2
   - b. 1
   - c. 3
   - d. 4
8.
   - a. 2, 3, and 5
   - b. 2 and 3
   - c. 1 and 4
   - d. 3
9.
   - a. Fuel
   - b. Heat
   - c. Oxygen
10. Evaluated to the satisfaction of the instructor.

ELECTRICAL SAFETY
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms and safety signs to their definitions or color codes and list facts about safety and fire prevention practices. The student should also be able to discuss proper dress, lifting techniques, third wires, ground fault interupters, safe practices for working around live conductors, and rescue procedures. The student will also be able to match ampere figures to their effect on the human body. This knowledge will be evidenced by scoring one hundred percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with electrical safety to the correct definitions.
2. Match safety signs or tags to their correct color codes.
3. State the two major causes of electrical accidents.
4. Select basic electrical safety practices.
5. List four electrical fire prevention practices.
6. Select safe practices for step ladders.
7. List four safety practices for job built and extension ladders.
8. Select safe practices for manual hand tools.
9. List safety practices for electrical hand tools.
10. Distinguish between proper and improper dress for electrical work.
11. List three proper lifting techniques.
12. List three facts about the importance of the third wire.
13. Discuss ground fault interupters.
14. Distinguish between safe and unsafe practices for working around live circuits.
15. Discuss rescue procedures in case of electrical accidents.
16. Match ampere figures at 120v, 60 hertz (cycle) to its effect on the human body.

ELECTRICAL SAFETY
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information sheet.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Safety Tag Color Codes

      2. TM 2--Safety Tag Color Codes (Continued)

      3. TM 3--Safety Tag Color Codes (Continued)

      4. TM 4--Safety Tag Color Codes (Continued)

      5. TM 5--Fire Prevention

      6. TM 6--Safety Practices for Step Ladders

      7. TM 7--Safe Ladder Angle

      8. TM 8--Maintain Tools

9. TM 9--Lifting Techniques
10. TM 10--Rescue Procedures
11. TM 11--Rescue Procedures (Continued)

D. Test

E. Answers to test

II. References:

A. *National Electrical Code*, 1981. Boston: National Fire Protection Association, 1980.

B. *Construction Safety and Health Training Course*. U.S. Department of Labor, Occupational Safety and Health Administration. OSHA 2044.

III. Additional references:

A. U.S. Department of Labor, *Control of Electric Shock Hazards*. Bulletin 216, 1961.

B. Federal Register, Vol. 37, No. 202 (Wednesday October 18, 1972) 22239-22242.

ELECTRICAL SAFETY
UNIT III

INFORMATION SHEET

I. Terms and definitions

   A. Ground fault interupter--Personal protection device that stops current flow when an imbalance occurs between current carrying conductors

   B. Occupational Safety and Health Act (O.S.H.A.)--Federal legislation designed to insure safe and sanitary working conditions for employees

   C. Ampere--A measure of the intensity of electron flow

   D. Volts--Unit measure for electrical pressure

   E. Hertz--One positive to negative change in an alternating current circuit

   F. Multi-outlet assembly--A type of surface or flush raceway designed to hold conductors and receptacles

   G. Cube tap--A device that plugs into a receptacle and provides space for connection of two or more attachment plugs

II. Color coding of safety tags or signs

   A. Do not start tag (Transparency 1)

      1. White tag

      2. White letters on red square

   B. Danger tag (Transparency 2)

      1. White tag

      2. White letters in red oval, on black square

   C. Caution tag (Transparency 3)

      1. Yellow tag

      2. Yellow letters on black background

   D. Out of order tag (Transparency 4)

      1. White tag

      2. White letters on black background

INFORMATION SHEET

III. Major causes of electrical accidents

  A. Carelessness

  B. Misuse

IV. Basic electrical safety practices

  A. Never underestimate the danger of 110v AC circuits

  (NOTE: More people die from 110v AC electrical shock than any other voltage. This is mostly due to a lack of respect.)

  B. Watch out for electrical arcs, they can cause bad burns

  C. Remember, mild shocks can cause personal injury or injury to others by your reaction

  D. Never install equipment that will overload a circuit

  E. Never bypass a fuse

  F. Be sure all current carrying electric lines are well insulated

  G. Always check a circuit for voltage before servicing

  H. Work on live circuits only when absolutely necessary

V. Fire prevention practices (Transparency 5)

  A. Use extension cords only within their designated rating

  B. Never let multi-outlet assemblies or cube taps cause overloads

  C. Never use frayed or deteriorated extension cords

  D. Never tamper with fuses to change their current carrying capacity

VI. Safe practices for step ladders (Transparencies 6 and 7)

  A. Never leave tools or equipment on footsteps or top

  B. Never stand on ladder tops

  C. Never use damaged ladders until repaired

  D. Set ladders on firm level surface

  (NOTE: Block up legs if necessary to firm up a ladder.)

  E. Never use aluminum ladders in electrical work

  F. Have attendant if located in a walkway or roadway

INFORMATION SHEET

VII. Safety practices for job built and extension ladders

- A. Secure top of ladder when possible
- B. Make sure ladder is tall enough

  (NOTE: Top step should be platform height so that the worker can exit through rails rather than around.)
- C. Use nonskid feet or secure the base
- D. Maintain safe ladder angle

VIII. Safe practices for manual hand tools (Transparency 8)

- A. Never hit tempered metals such as hammer faces together
- B. Watch for mushrooming effect on chisels
- C. Rebevel the heads of damaged chisels before using them

  (NOTE: Wear eye protection appropriate for grinding.)
- D. Watch for deterioration and breaks in wood handled tools

  (NOTE: Replace if damaged. Do not try to tape or repair them.)
- E. Use appropriate tool for the job
- F. Keep sharp edged tools sheathed or covered

IX. Safety practices for electrical hand tools

- A. All tools should have proper guards
- B. Clothing should not be loose when using tools
- C. Eye protection should be used
- D. Lock on devices should not be used
- E. Tools with frayed or damaged cords should not be used
- F. Grounding contact should be in all cord bodies except those on double insulated tools

INFORMATION SHEET

X. Proper dress for electrical work
   - A. Do not wear loose clothing
   - B. Wear hard hats on all construction sites
   - C. Wear safety shoes
   - D. Wear appropriate eye protection
   - E. Wear hearing protection when subjected to continuous loud noise
   - F. Wear dust masks in dusty areas

XI. Proper lifting techniques (Transparency 9)
   - A. Keep back straight
   - B. Lift with your legs
   - C. Get help for heavy objects

XII. Importance of third wire
   - A. Installed for personal protection
   - B. Provides alternate path for current in case of a short
   - C. Can save your life

XIII. Ground fault interupters
   - A. Personal safety devices
   - B. Required on 15 and 20 ampere receptacle outlets used for temporary supply on construction sites
   - C. Stops current before severe personal injury occurs

XIV. Safety practices around live circuits
   - A. Use a neon test light or voltmeter to identify live circuits
   - B. Stand on dry surface
   - C. Use only one hand if possible
   - D. Never keep tools lying around live conductors
   - E. Wear suitable insulated hand covering
   - F. Return all tools to pouch when through with them

INFORMATION SHEET

XV. Rescue procedures (Transparencies 10 and 11)

(NOTE: These procedures apply to 120-240 volt locations.)

A. Locate live wire and disconnect if possible

(CAUTION: Do not take hold of the person with your bare hand.)

B. Decide whether it would be easier to move the person or the conductor

(CAUTION: If conductor is to be moved use dry limb or some other nonconductive equipment; if person's body is to be moved use several thicknesses of paper or cloth as an insulator.)

C. With paper or cloth in hand quickly pull victim free of the conductor

(NOTE: These decisions must be made quickly. After five minutes the chances of saving an individual decrease greatly.)

XVI. Amperes and their effects on the human body at 120v, 60 hertz (cycle)

A. .0005 or less amperes--No sensation

B. .0005 to .002 amperes--Threshold of perception

C. .002 to .010 amperes--Muscular contraction (mild to strong)

D. .005 to .025 amperes--Painful shock, inability to let go

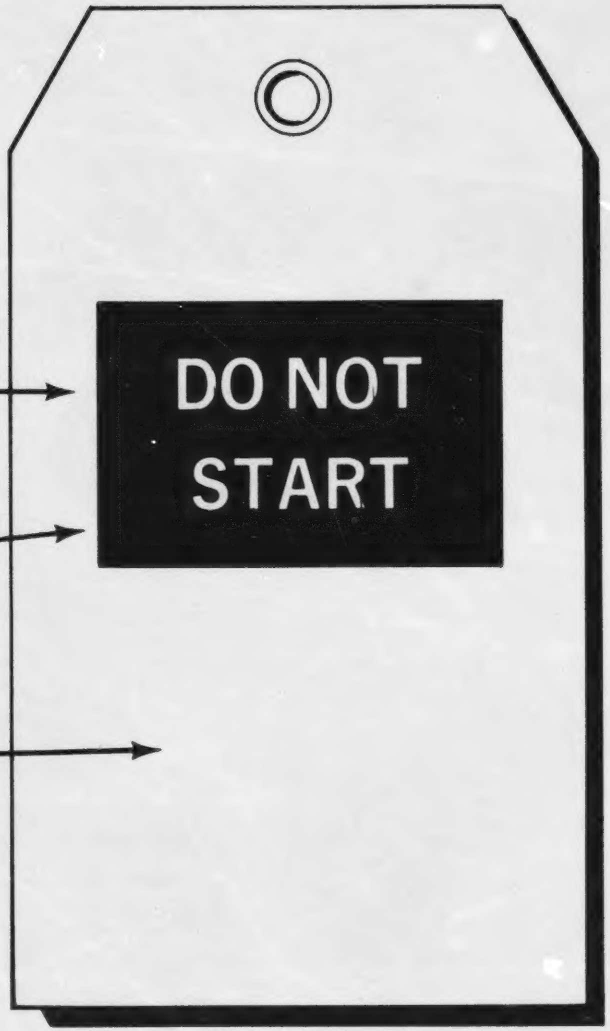
E. .025 to more amperes--Violent muscular contraction

F. .050 to .200 amperes--Ventricular fibrillation (convulsive movement of the heart-fatal)

G. over .100 amperes--Paralysis of breathing (apply artificial respiration immediately)

SAFETY TAG COLOR CODES

"Do Not Start" Tag


DO NOT
START

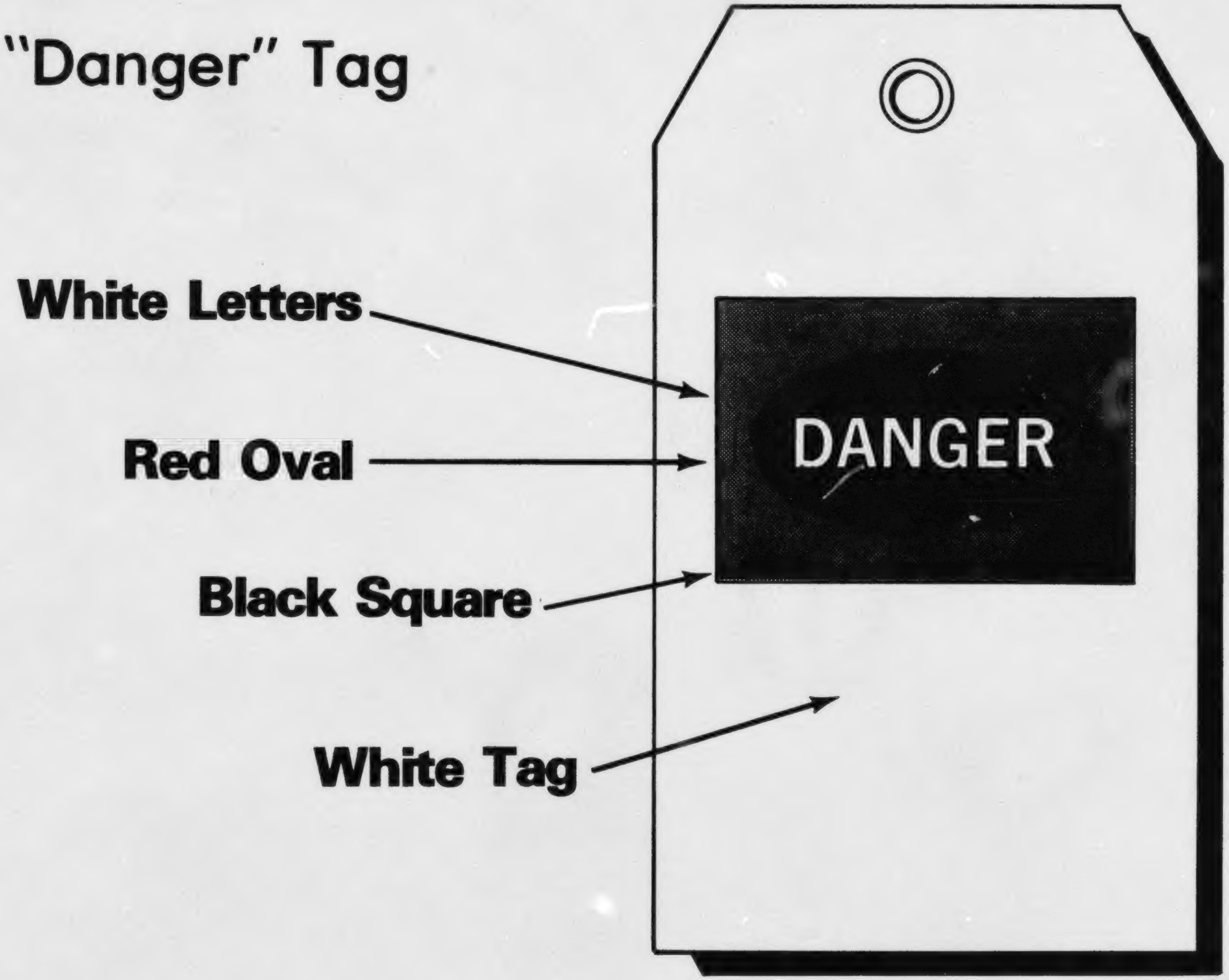
White Letters

Red Square

White Tag

SAFETY TAG COLOR CODES (Cont)

"Danger" Tag



White Letters

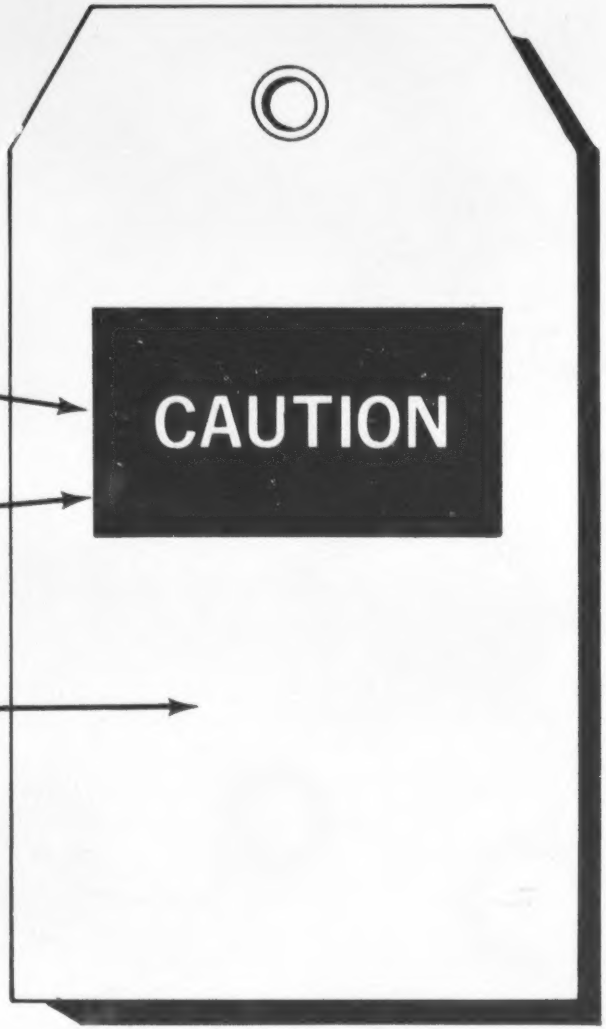
Red Oval

Black Square

White Tag

SAFETY TAG COLOR CODES (Cont)

"Caution" Tag



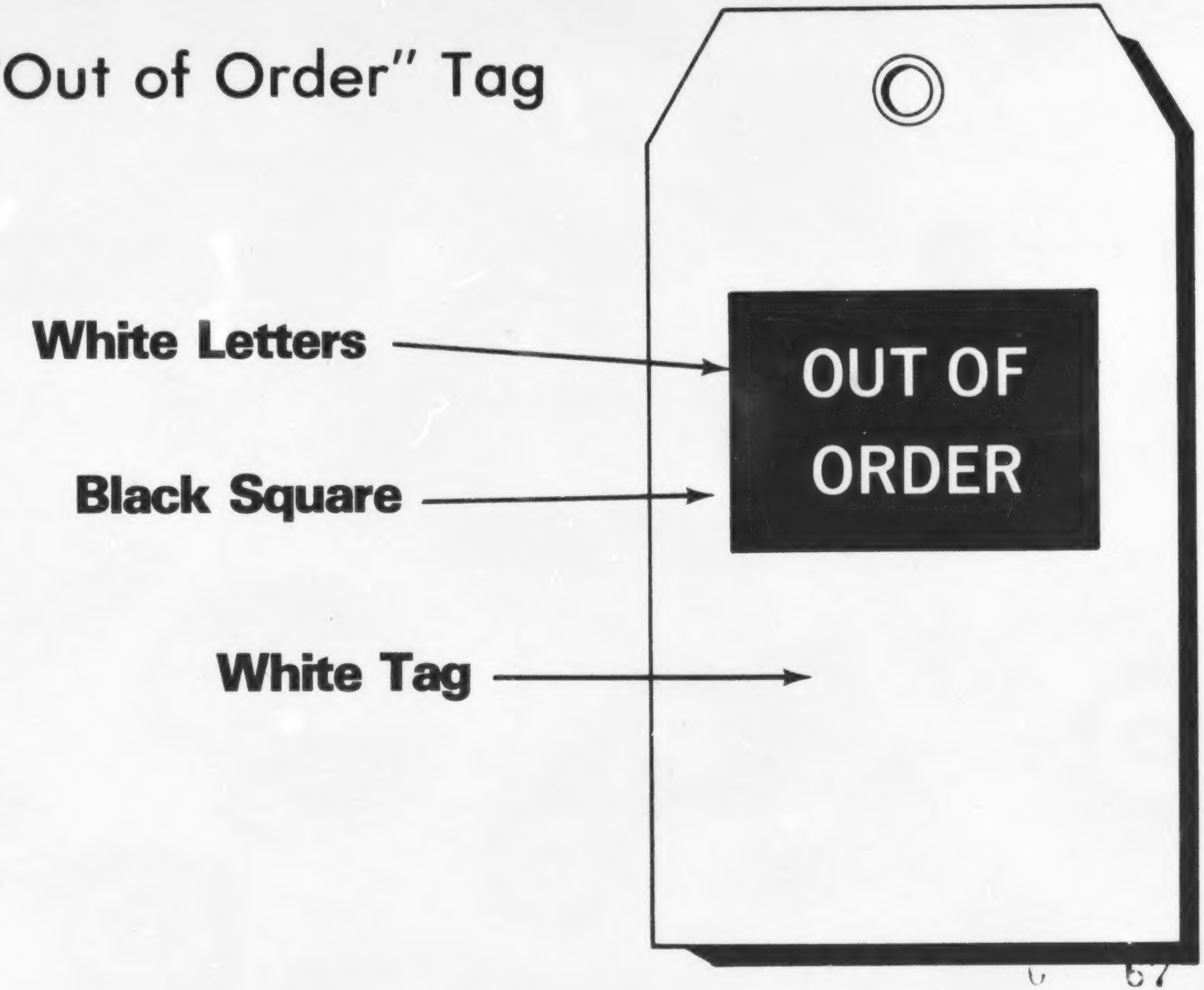
Yellow Letters

Black Square

Yellow Tag

SAFETY TAG COLOR CODES (Cont)

"Out of Order" Tag


OUT OF ORDER

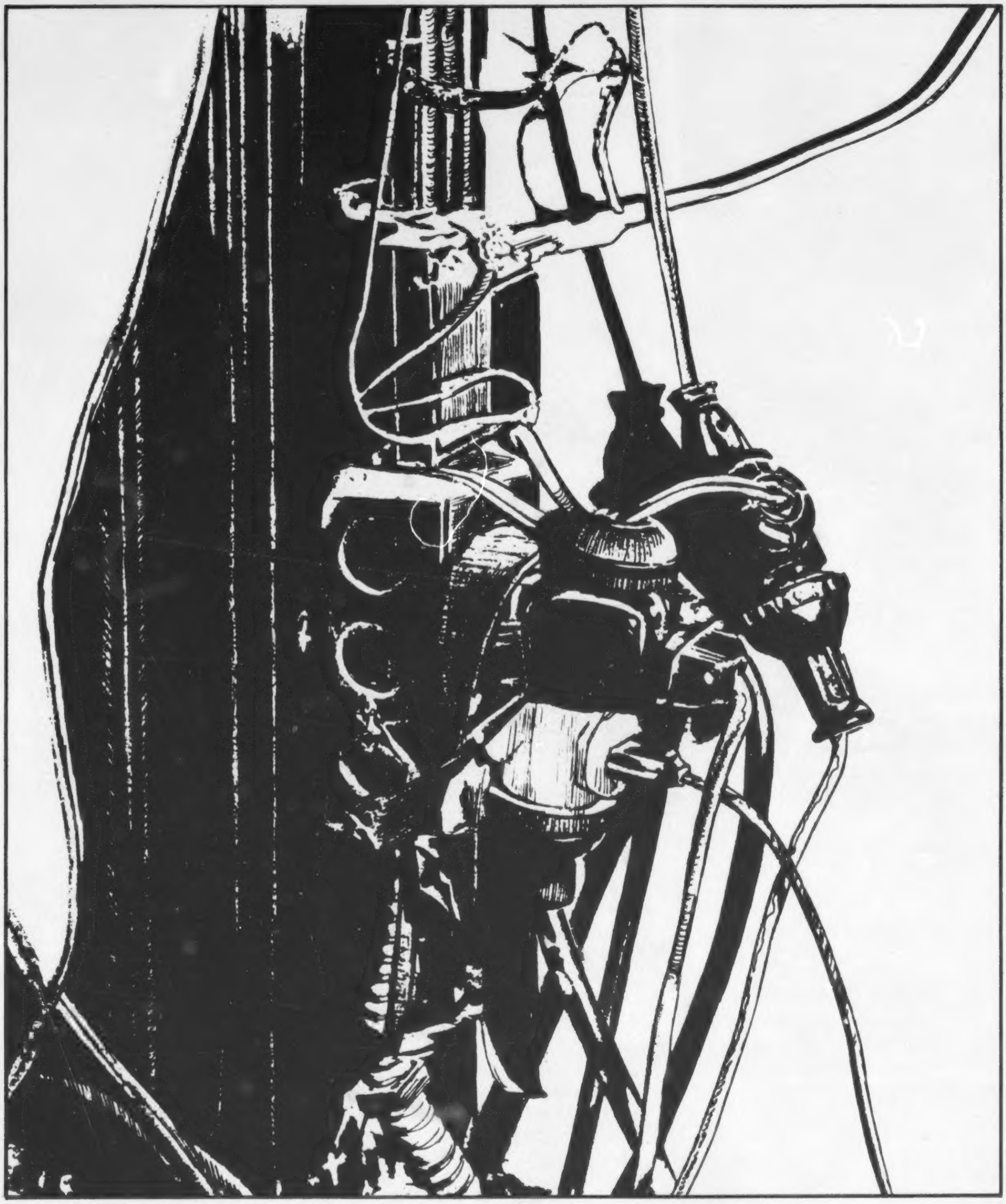
White Letters

Black Square

White Tag

R - 55-A

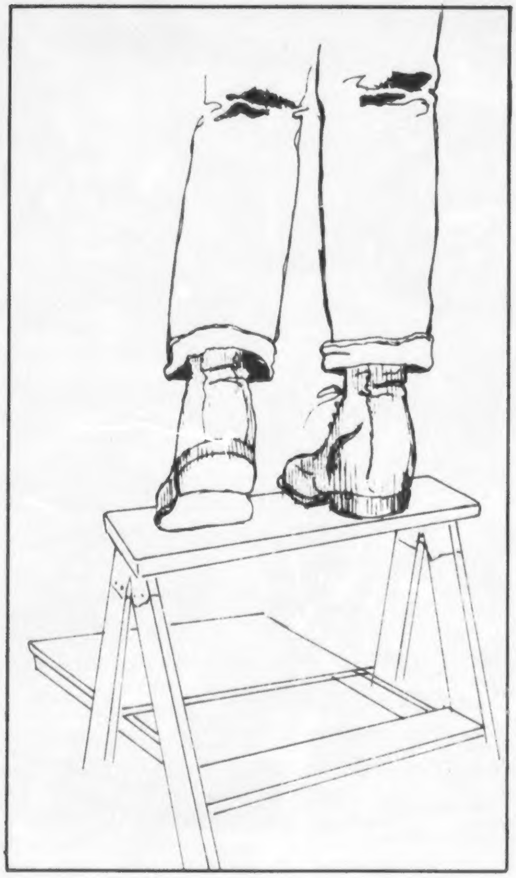
FIRE PREVENTION



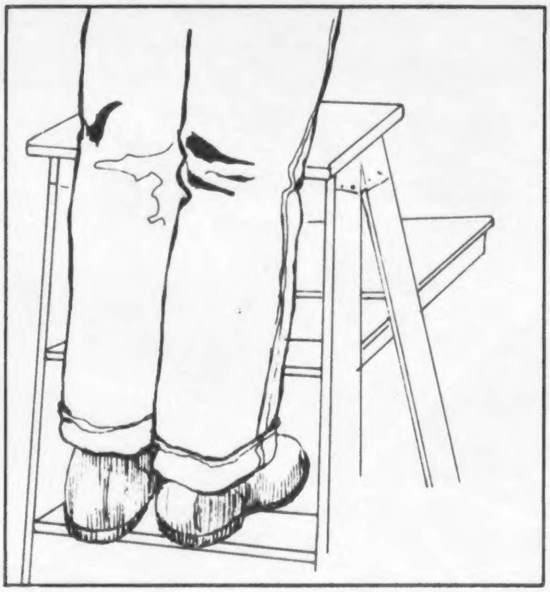
Improper use of electrical equipment is dangerous

TM 5

Safety Practices for Step Ladders

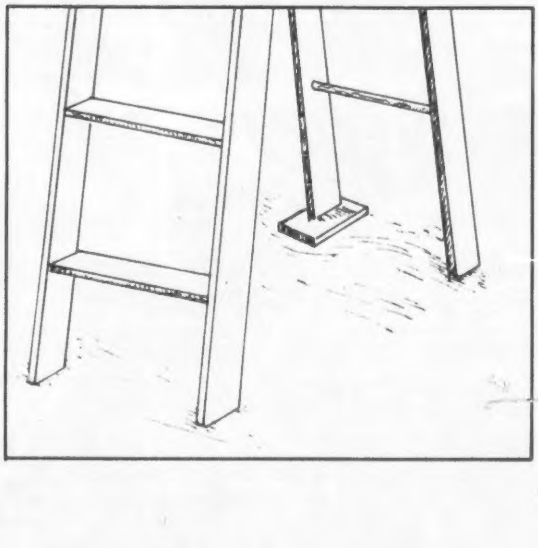


INCORRECT



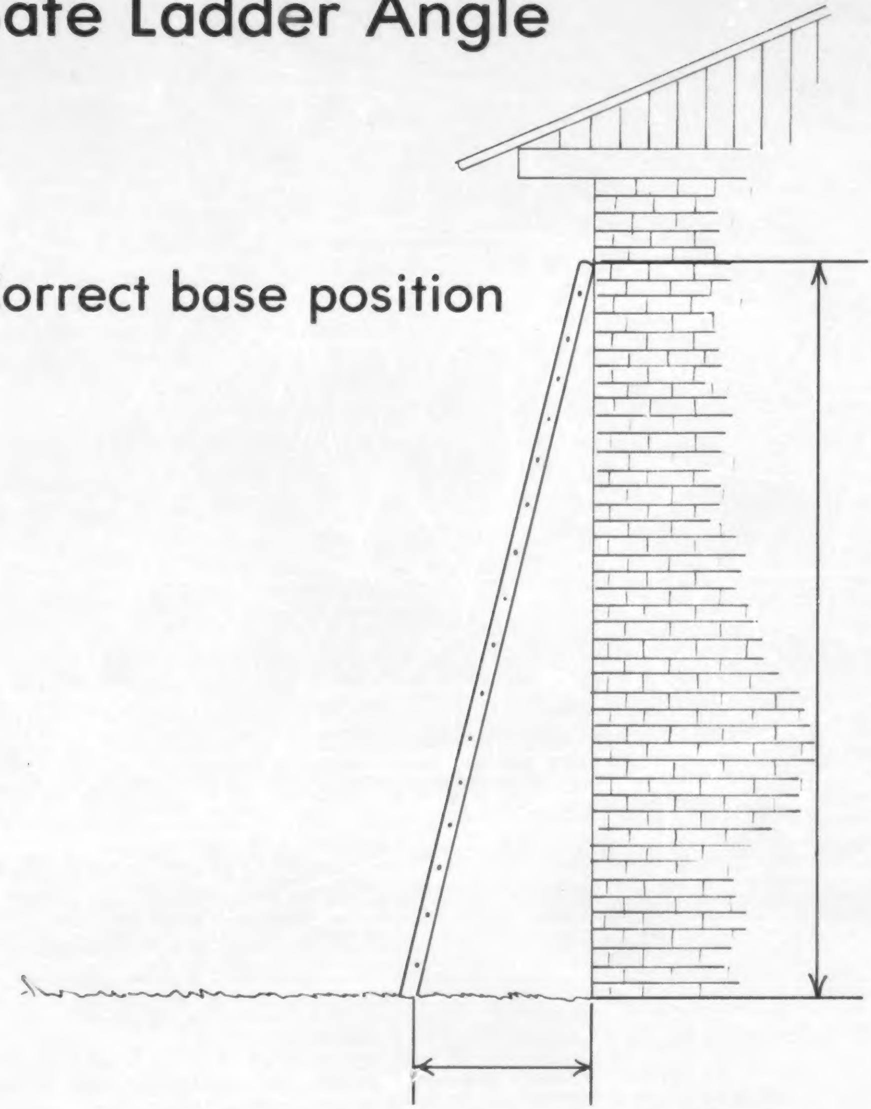
CORRECT

USE BLOCK TO LEVEL LADDER
WHEN NECESSARY



Safe Ladder Angle

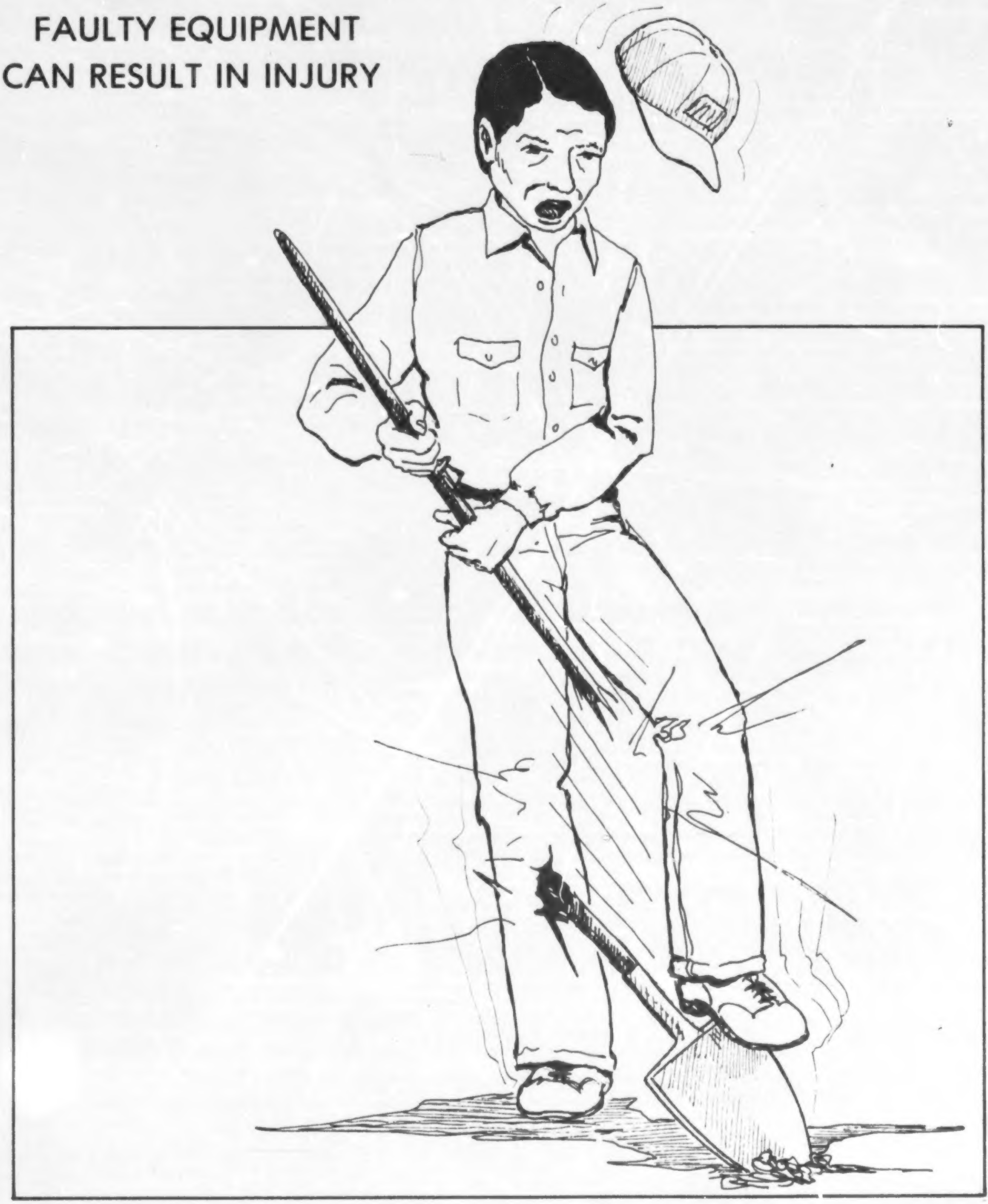
Correct base position



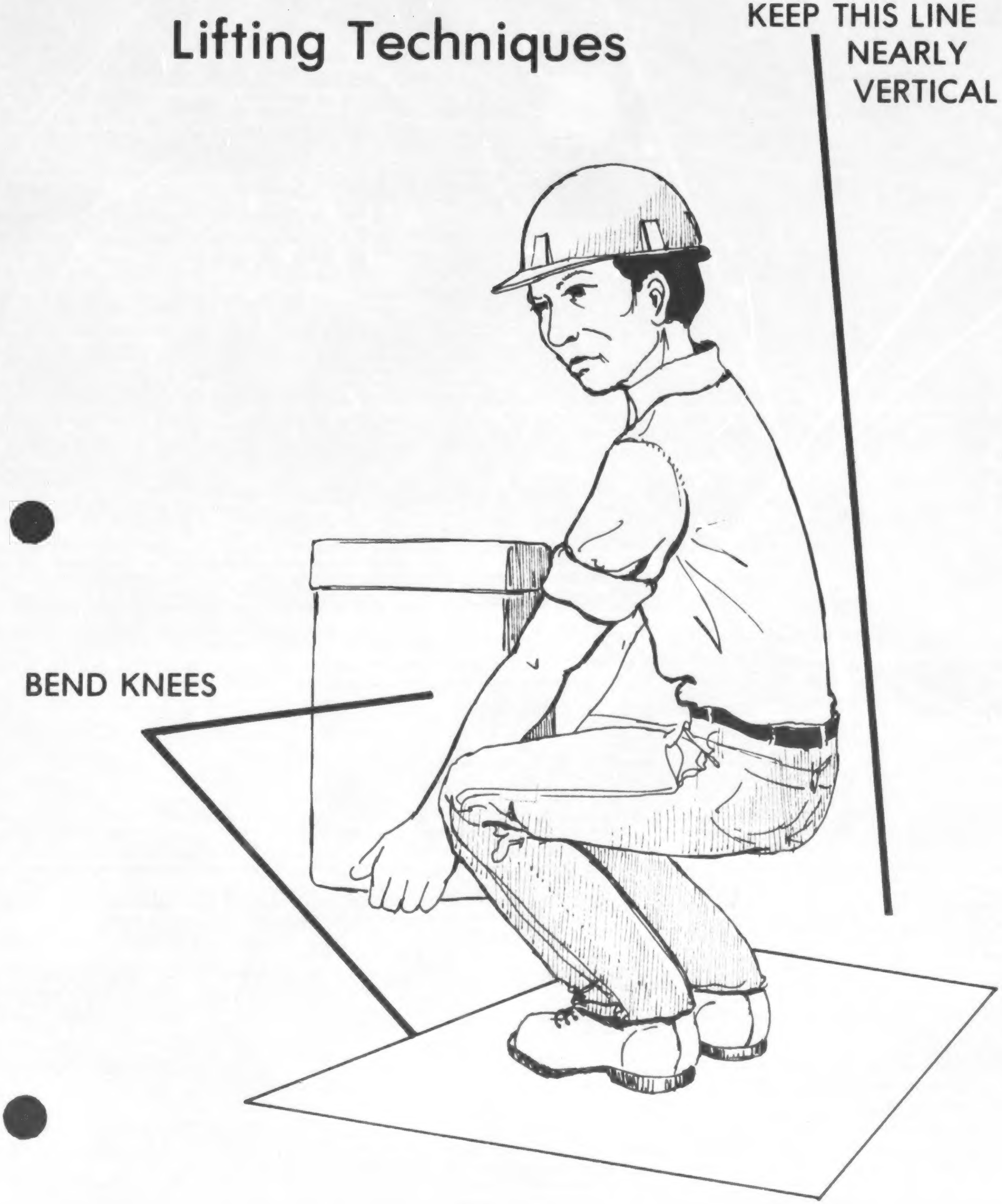
CORRECT BASE POSITION IS ¼ THE VERTICAL HEIGHT

Maintain Tools

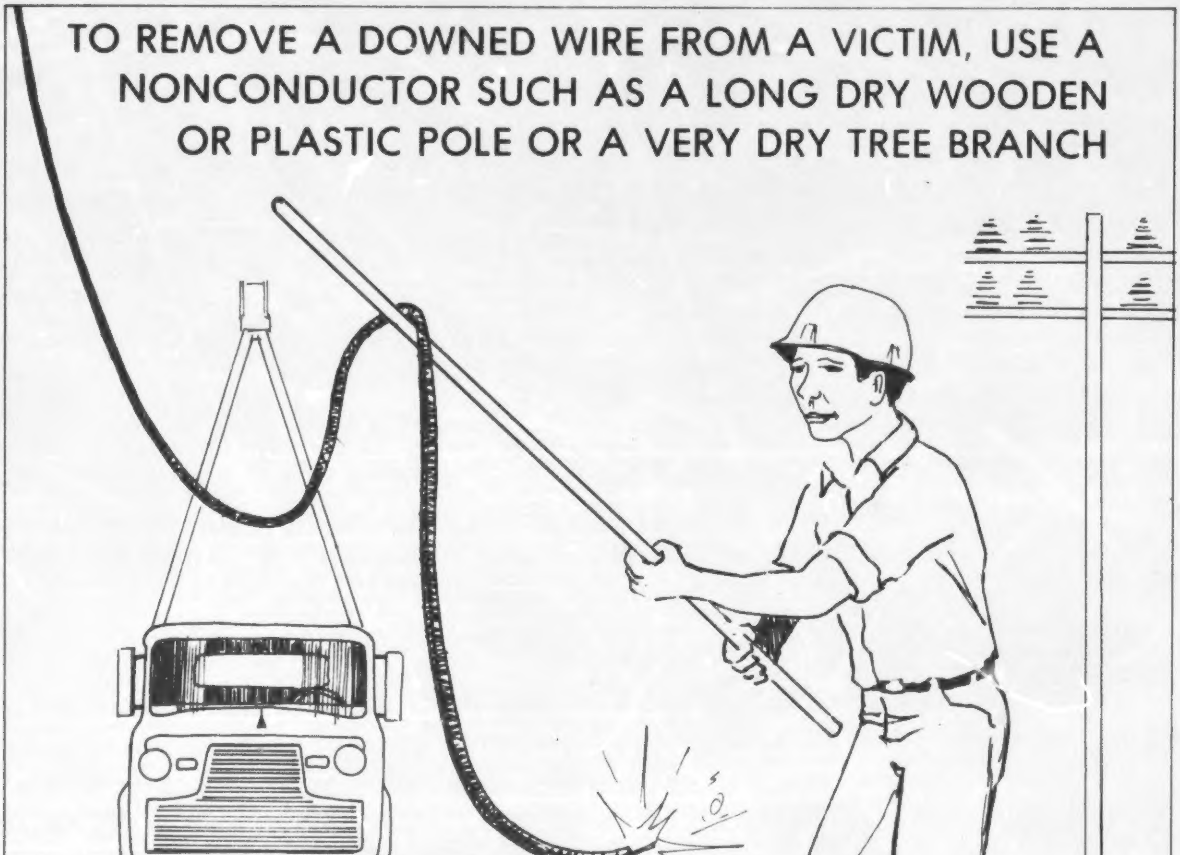
FAULTY EQUIPMENT
CAN RESULT IN INJURY



Lifting Techniques

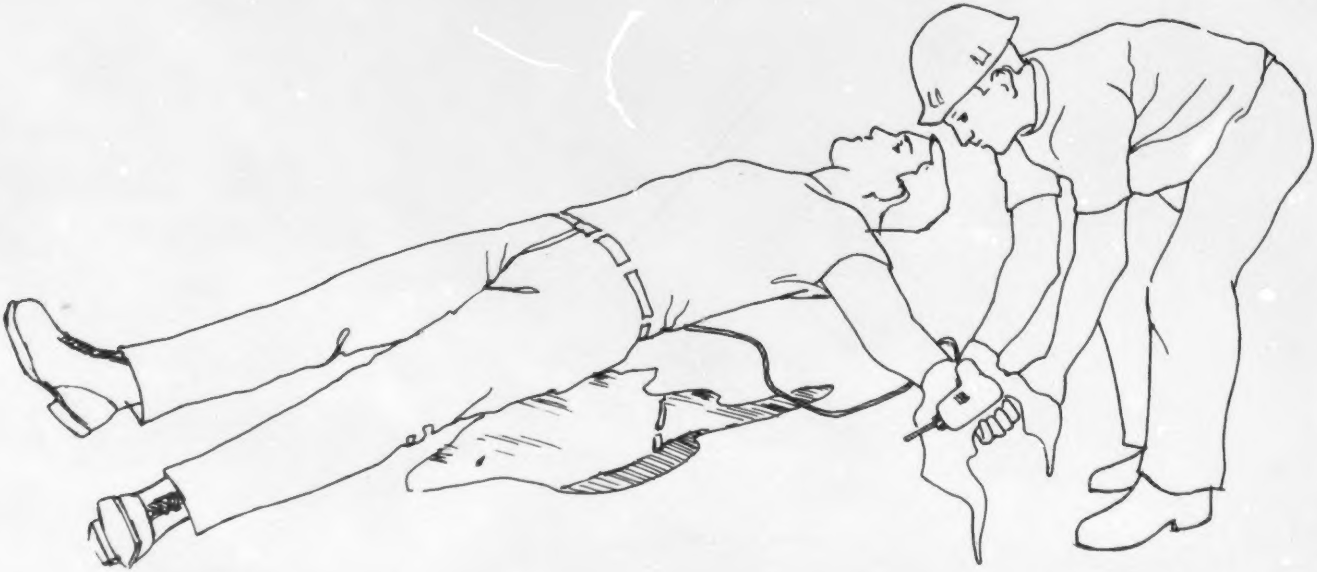

KEEP THIS LINE
NEARLY
VERTICAL
BEND KNEES

Rescue Procedures



TO REMOVE A DOWNED WIRE FROM A VICTIM, USE A NONCONDUCTOR SUCH AS A LONG DRY WOODEN OR PLASTIC POLE OR A VERY DRY TREE BRANCH

Rescue Procedures
(Continued)



DO NOT ATTEMPT TO REMOVE A VICTIM
WITHOUT SOME FORM OF INSULATION
SUCH AS PAPER OR CLOTH TO PROTECT YOURSELF

ELECTRICAL SAFETY
UNIT III

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Personal protection device that stops current flow when an imbalance occurs between current carrying conductors

_____b. Federal legislation designed to insure safe and sanitary working conditions for employees

_____c. A measure of the intensity of electron flow

_____d. Unit measure for electrical pressure

_____e. One positive to negative change in an alternating current circuit

_____f. A type of surface or flush raceway designed to hold conductors and receptacles

_____g. A device that plugs into a receptacle and provides space for connection of two or more attachment caps

1. Hertz
2. Ampere
3. Multi-outlet assembly
4. Ground fault interupter
5. Occupational Safety and Health Act (O.S.H.A.)
6. Volts
7. Cube tap

2. Match the following signs or tags to their correct color coding.

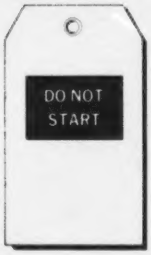
_____a. White tag, white letters on red square

_____b. White tag, white letters in red oval, on black square

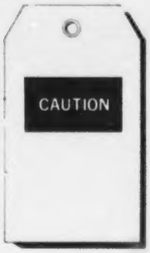
_____c. Yellow tag, yellow letters on black background

_____d. White tag, white letters on black background

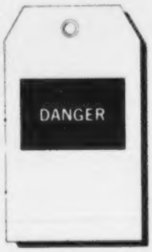
1.



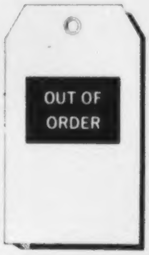
2.



3.



4.



3. State the two major causes of electrical accidents.

a.

b.

4. Select the basic electrical safety practices by placing an "S" in the appropriate blanks.

_____a. Since 110 volts is relatively low some safety rules can be ignored

_____b. Watch out for electrical arcs, they can cause bad burns

_____c. Remember, mild shocks can cause personal injury or injury to others by your reaction

_____d. Slight overloads are acceptable on most circuits

_____e. Never bypass a fuse

_____f. Always check a circuit for voltage before servicing

5. List four electrical fire prevention practices.

   a.

   b.

   c.

   d.

6. Select safe practices for step ladders by placing an "X" in the appropriate blanks.

   ______a. Never leave tools or equipment on footsteps or top

   ______b. Stand on ladder tops only when necessary

   ______c. Never use damaged ladders until repaired

   ______d. Be careful when using aluminum ladder for electrical work

   ______e. Never go to the top of a ladder set on an uneven surface

   ______f. Step over broken or cracked footsteps

7. List four safety practices for job built and extension ladders.

   a.

   b.

   c.

   d.

8. Select safe practices for manual hand tools by placing an "S" in the appropriate blanks.

   ______a. Never hit tempered metals such as hammer faces together

   ______b. Tape all cracked wooden handles

   ______c. Rebevel the heads of damaged chisels before using them

   ______d. Shovels can be used for driving wooden stakes

   ______e. Use appropriate tool for the job

   ______f. Keep sharp edged tools sheathed or covered

9. List five safety practices for electrical hand tools.

   a.

   b.

   c.

   d.

   e.

10. Distinguish between proper and improper dress for electrical work by placing a "P" in front of the proper dress items.

    _____a. Ties when working inside

    _____b. Loose clothing

    _____c. Hard hats on all construction sites

    _____d. Safety shoes

    _____e. Appropriate eye protection

    _____f. Dust masks in dusty areas

11. List three proper lifting techniques.

    a.

    b.

    c.

12. List three facts about the importance of the third wire.

    a.

    b.

    c.

13. Discuss ground fault interupters.

14. Distinguish between safe and unsafe practices for working around live circuits by placing an "S" in front of safe practices.

_____a. Use a neon test light or voltmeter to identify live circuits

_____b. Stand on wet concrete only in emergency

_____c. Use only one hand if possible

_____d. Never keep tools lying around live conductors

_____e. Wear suitable insulated hand covering

15. Discuss rescue procedures in case of electrical accidents.

16. Match the ampere figures to the effects on the human body.

_____a. No sensation

_____b. Threshold of perception

_____c. Muscular contraction (mild to strong)

_____d. Painful shock, inability to let go

_____e. Violent muscular contraction

_____f. Ventricular fibrillation (convulsive movement of the heart-fatal)

_____g. Paralysis of breathing (apply artificial respiration immediately)

1. over .100 amperes
2. .0005 or less amperes
3. .050 to .200 amperes
4. .002 to .010 amperes
5. .0005 to .002 amperes
6. .005 to .025 amperes
7. .025 or more amperes

ELECTRICAL SAFETY
UNIT III

ANSWERS TO TEST

1. a. 4
   b. 5
   c. 2
   d. 6
   e. 1
   f. 3
   g. 7
2. a. 1
   b. 3
   c. 2
   d. 4
3. a. Carelessness
   b. Misuse
4. b, c, e, f
5. a. Use extension cords only within their designated rating
   b. Never let multi-outlet assemblies or cube taps cause overloads
   c. Never use frayed or deteriorated extension cords
   d. Never tamper with fuses to change their current carrying capacity
6. a, c
7. a. Secure top of ladder when possible
   b. Make sure ladder is tall enough
   c. Use nonskid feet or secure the base
   d. Maintain safe ladder angle

8. a, c, e, f

9. Any five of the following:

   a. All tools should have proper guards

   b. Clothing should not be loose when using tools

   c. Eye protection should be used

   d. Lock on devices should not be used

   e. Tools with frayed or damaged cords should not be used

   f. Grounding contact should be in all cord bodies except those on double insulated tools

10. c, d, e, f

11. a. Keep back straight

   b. Lift with your legs

   c. Get help for heavy objects

12. a. Installed for personal protection

   b. Provides alternate path for current in case of a short

   c. Can save your life

13. Discussion should include:

   a. Personal safety device

   b. Required on 15 and 20 ampere receptacle outlets used for temporary supply on construction sites

   c. Stops current before severe personal injury occurs

14. a, c, d, e

15. Discussion should include:

   a. Locate live wire and disconnect if possible

   b. Decide whether it would be easier to move the person or the conductor

   c. With paper or cloth in hand quickly pull victim free of the conductor

16.
a. 2
b. 5
c. 4
d. 6
e. 7
f. 3
g. 1

POUCH TOOLS
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to match the names of commonly used pouch tools to their appropriate pictures. The student should know common uses of the basic tools as well as selection and maintenance techniques. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match tool names to the appropriate pictures.
2. Match tools to the common trade uses.
3. List factors that should be considered when selecting tools and pouches.
4. List maintenance procedures for tools and pouches.
5. Demonstrate the ability to:
    a. Cut cable using lineman's pliers.
    b. Clean and lubricate pliers.
    c. Grind a flat blade screwdriver.
    d. Adjust wire strippers.
    e. Trim conductor insulation using a knife.

POUCH TOOLS
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide student with objective sheet.
- B. Provide student with information and job sheets.
- C. Make transparencies.
- D. Discuss unit and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss the procedures outlined in the job sheets.
- G. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Complete job sheets.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Transparency masters
    1. TM 1--Tools and Pouch
    2. TM 2--Tools and Pouch (Continued)
    3. TM 3--Folding Rule
    4. TM 4--Tap Tool

    5. TM 5--Adjustable Wrench
    6. TM 6--Screwdrivers
    7. TM 7--Pliers
    8. TM 8--Neon Test Light

D. Job sheets

    1. Job Sheet #1--Cut Cable Using Lineman's Pliers
    2. Job Sheet #2--Clean and Lubricate Pliers
    3. Job Sheet #3--Grind a Flat Blade Screwdriver
    4. Job Sheet #4--Adjust Wire Strippers
    5. Job Sheet #5--Trim Conductor Insulation Using a Knife

E. Test

F. Answers to test

II. Reference--*Klein Tools and Safety Equipment.* General Catalog 120. Chicago, Illinois.

POUCH TOOLS
UNIT I

INFORMATION SHEET

I. Tools and pouch (Transparencies 1 and 2)

   A. Folding rule with sliding scale

   B. Tap tool

   C. Adjustable wrench

   D. Flat blade screwdriver

   E. Phillips head screwdriver

   F. Stubby screwdrivers

      (NOTE: Stubby screwdrivers can be flat blade or phillips head.)

   G. Adjustable wire strippers

   H. Six in one tool

   I. Long nose pliers

      (NOTE: These are sometimes referred to as needle nose.)

   J. Lineman's pliers (side cutters)

   K. Diagonal pliers

   L. Groove joint pliers

      (NOTE: These are also commonly called channel locks or pump pliers.)

   M. Pocket knife

      (NOTE: A pocket knife should have a locking blade.)

   N. Electrician's hammer

   O. Tool pouch

   P. Neon test light

   Q. Awl

INFORMATION SHEET

II. Tools and their uses

  A. Folding rule with sliding scale (Transparency 3)

    1. Measuring distances on prints
    2. Locating boxes
    3. Determining depth and setout

  B. Tap tools (Transparency 4)

    1. Tapping drill holes for securing equipment to metal
    2. Enlarging holes and tapping for larger screw
    3. Retapping damaged threads
    4. Determining screw sizes

  C. Adjustable wrench (Transparency 5)

    1. Tightening couplings and connectors
    2. Tightening pressure type wire connectors
    3. Removing and holding nuts

  D. Flat blade screwdriver (Transparency 6)

    1. Removing and installing slot head screws
    2. Tightening and loosening slot head lugs

  E. Phillips head screwdriver (Transparency 6)

    1. Removing and installing phillips head screws
    2. Tightening and loosening phillips head lugs

  F. Stubby screwdrivers (Transparency 6)

    1. Removing and installing screws in limited working space
    2. Tightening and loosening lugs in limited working space

INFORMATION SHEET

G. Adjustable wire strippers

  1. Stripping insulation from conductors

  2. Cutting conductors

  3. Forming conductors

H. Six in one tool

  1. Stripping insulation

  2. Cutting conductors

  3. Cutting small bolts

I. Long nose pliers (Transparency 7)

  1. Forming small conductors

  2. Stripping conductors

     (NOTE: Needle nose pliers can be purchased with a stripping slot.)

  3. Cutting conductors

  4. Holding and pulling on conductors

J. Lineman's pliers (side cutters) (Transparency 7)

  1. Cutting cables and conductors

  2. Cutting small screws

  3. Stripping conductors

  4. Forming large conductors

  5. Pulling and holding conductors

K. Diagonal pliers (Transparency 7)

  1. Cutting cables and conductors in limited space

  2. Stripping conductors

     (NOTE: Diagonal pliers can be purchased with a stripping slot.)

INFORMATION SHEET

- L. Groove joint pliers
  1. Holding and tightening couplings and connectors
  2. Holding and turning conduits and tubing
- M. Pocket knife
  1. Opening cartons
  2. Stripping large conductors and cables
- N. Electrician's hammer
  1. Driving and pulling nails
  2. Prying boxes loose
  3. Chipping wood
  4. Breaking plasterboard
- O. Neon test light (Transparency 8)
  1. Checking for live circuits
  2. Identifying conductors
- P. Awl
  1. Starting holes for screws
  2. Making drill starts

III. Factors that should be considered when selecting tools and pouches

- A. Tool size should be matched to the work most frequently encountered
- B. Tools should be specifically designed for electrical use when possible
  1. Should have insulation on handles of cutting pliers
  2. Should have straight claws on hammers
- C. Purchasing quality tools can save replacement costs

INFORMATION SHEET

D. Know the specifications before purchasing a tool

(NOTE: When in doubt about what tools are best, consult a practicing residential electrician in your area.)

Example:

1. Lineman's pliers--9" high leverage w/cushion grips and no. 12 stripping slot
2. Electrician's hammer--16 oz. w/straight claws, fiberglass shaft and cushion grip
3. Needle nose pliers--7" w/cushion grip and no. 12 stripping slot
4. Flat blade screwdriver--Electricians round shank, 6" X 3/16" blade w/cushion grips

E. Buy a pouch with enough space for the tools you will carry

1. Helps keep tools organized
2. Insures that you will be able to carry needed working tools

IV. Maintenance procedures

A. Screwdrivers

1. Regrind worn or damaged flat blade screwdrivers
2. Discard phillips screwdrivers with damaged heads

B. Pliers

1. Keep pliers clean and rust free
2. Keep cutting edges sharp and smooth
3. Keep pliers working freely
4. Repair or replace damaged handle insulation

C. Adjustable wrench--Keep worm gears clean and lubricated

D. Wood chisels--Keep cutting edge sharp and even

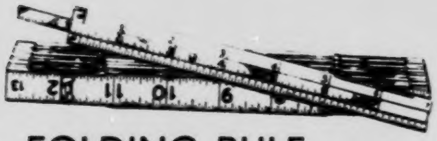
INFORMATION SHEET

E. Tool pouches--Keep oiled, clean, and soft

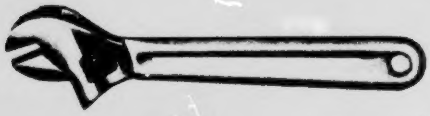
F. All tools--Identify tools by labeling them with an electric pencil or scratch awl

(NOTE: An identification mark can help you distinguish between your tools and someone else's.)

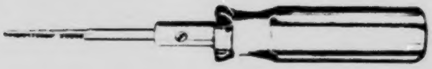
TOOLS AND POUCH



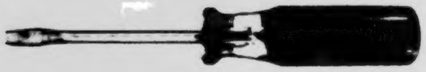
FOLDING RULE
WITH SLIDING SCALE



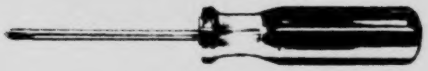
ADJUSTABLE WRENCH



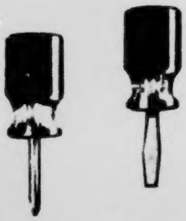
TAP TOOL



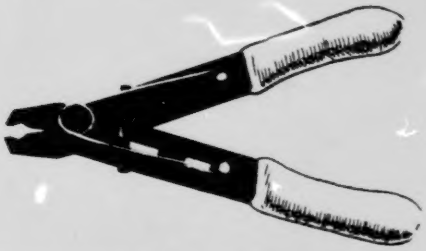
FLAT BLADE SCREWDRIVER



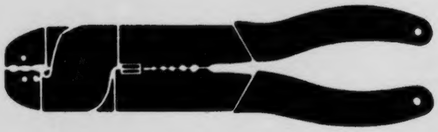
PHILLIPS HEAD SCREWDRIVER



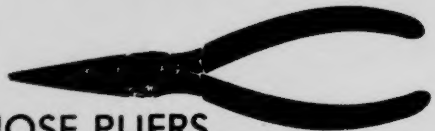
STUBBY SCREWDRIVERS



ADJUSTABLE WIRE STRIPPERS

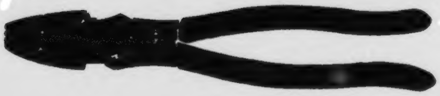


SIX IN ONE TOOL

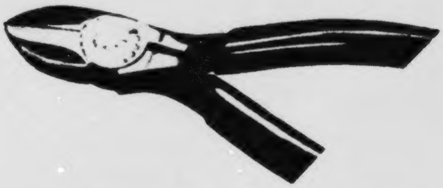


LONG NOSE PLIERS

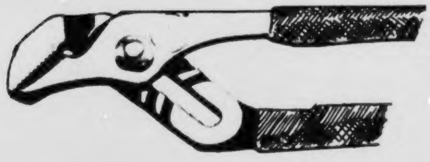
TOOLS AND POUCH (continued)



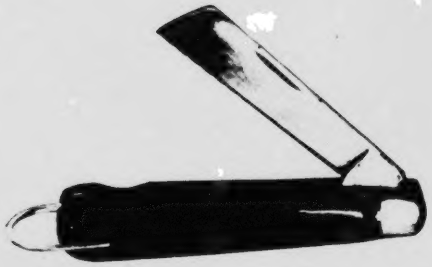
LINEMAN'S PLIERS



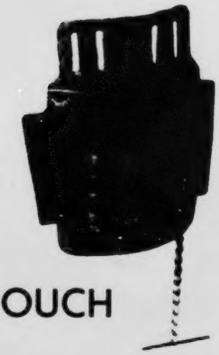
DIAGONAL PLIERS



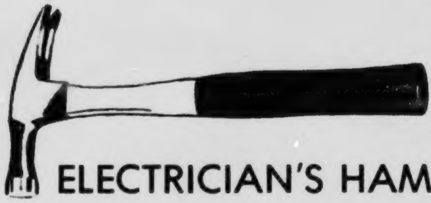
GROOVE JOINT PLIERS



POCKET KNIFE

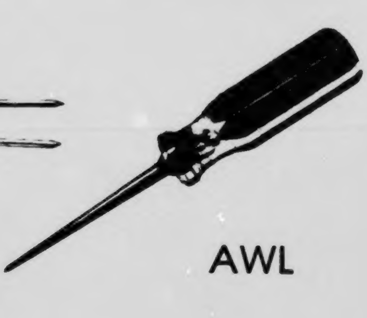


TOOL POUCH



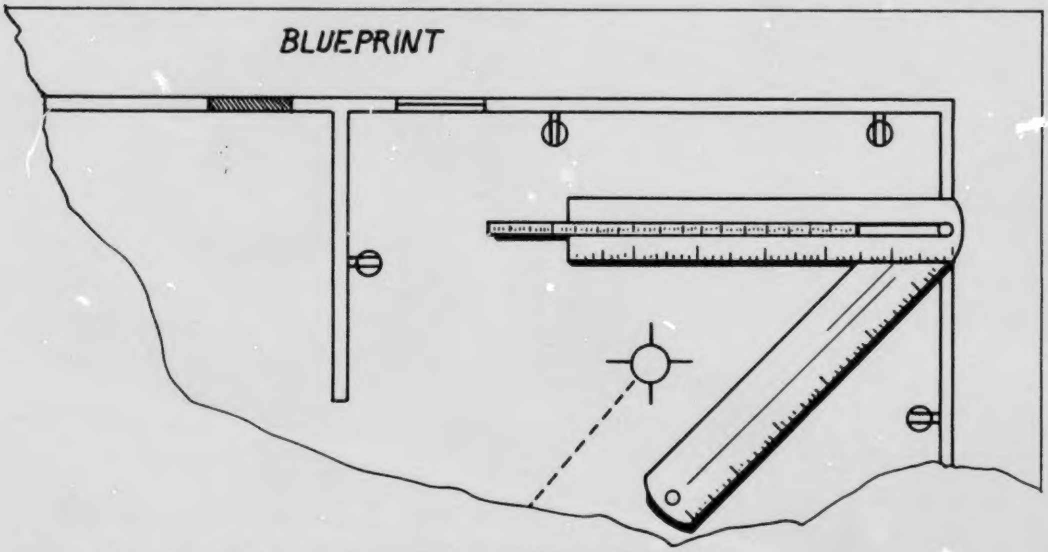
ELECTRICIAN'S HAMMER

NEON TEST LIGHT

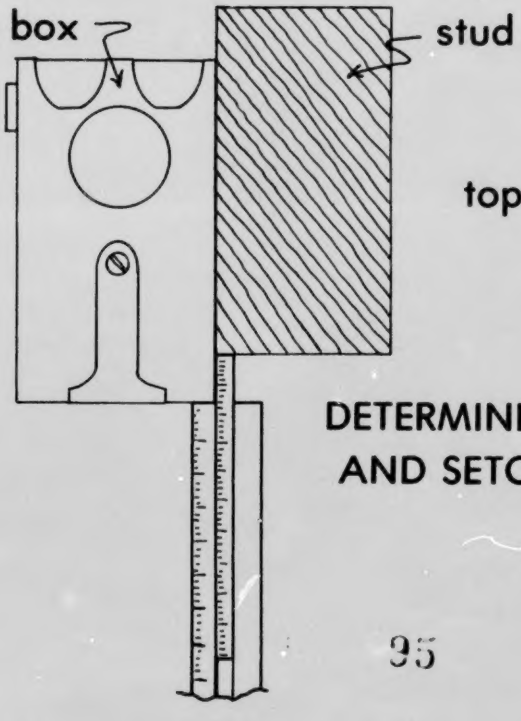


AWL

FOLDING RULE



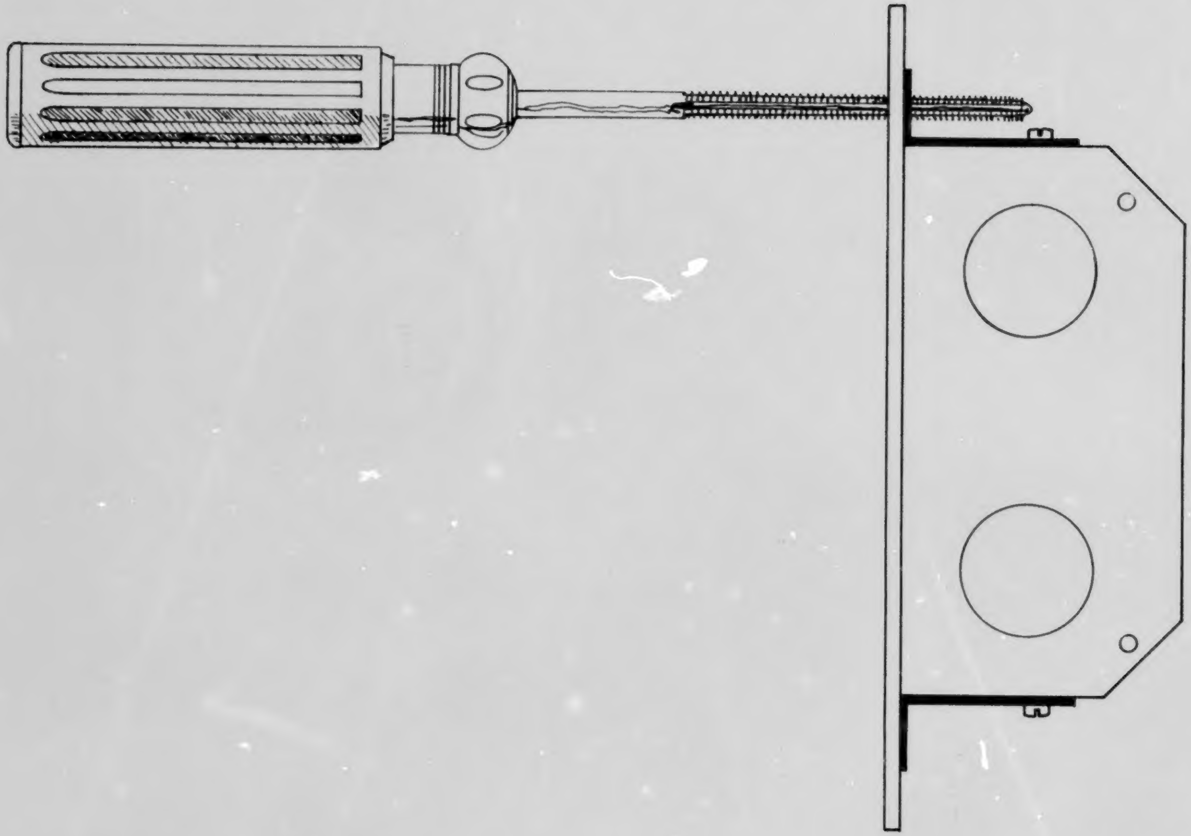
MEASURING DISTANCES ON PRINTS AND LOCATING BOXES


device box
stud
top view

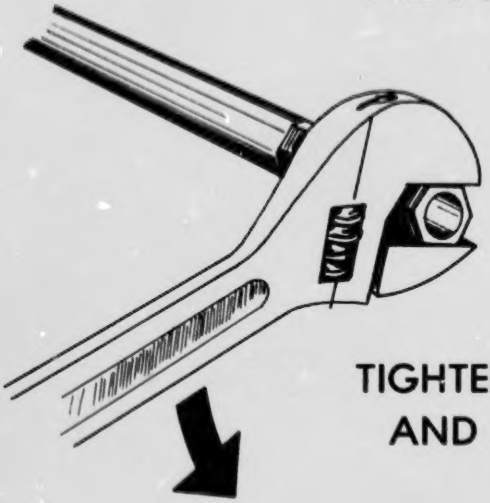
DETERMINING DEPTH AND SETOUT

TAP TOOL

RETAPPING DAMAGED THREADS



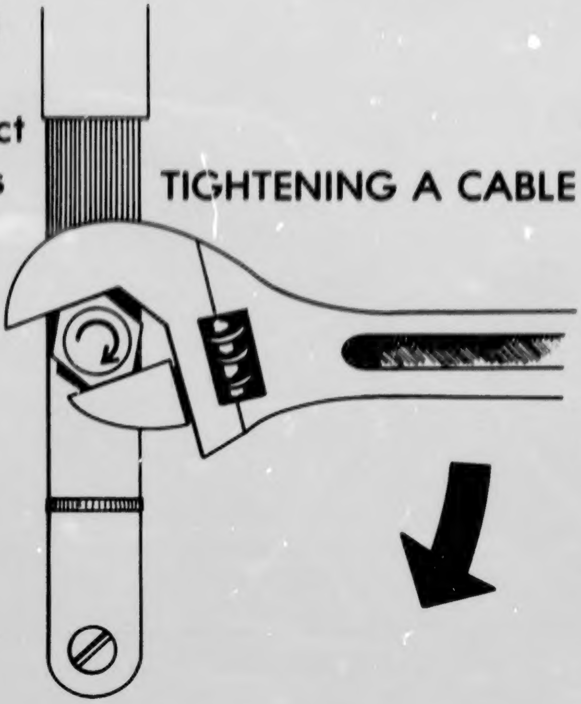
ADJUSTABLE WRENCH



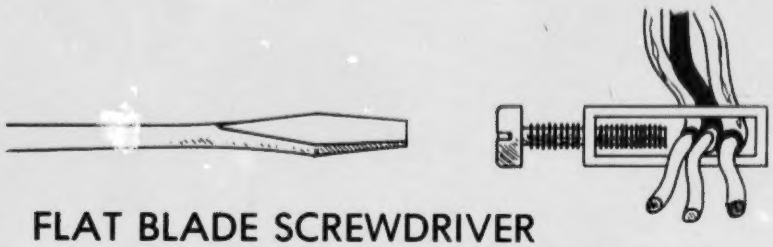
TIGHTENING COUPLINGS
AND CONNECTORS

(NOTE:
Always pull away from stationary jaw to avoid breaking or damaging wrench.
Arrows indicate correct direction for wrenches in their
current position.)

TIGHTENING A CABLE LUG

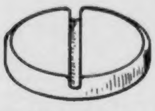


SCREWDRIVERS

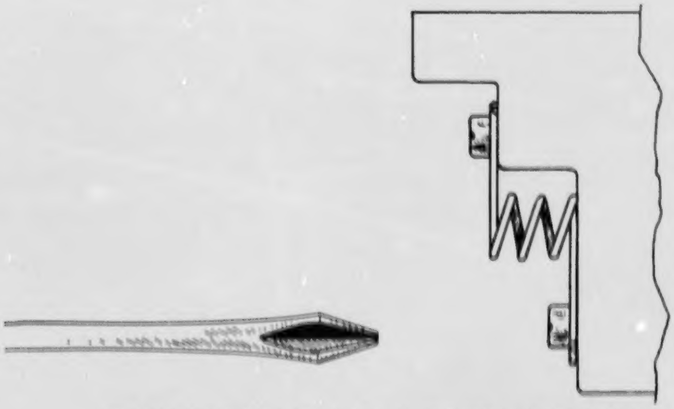


FLAT BLADE SCREWDRIVER
TIGHTENING A SLOT HEAD CONNECTOR

TYPE

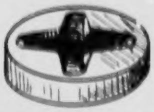


SCREW HEAD

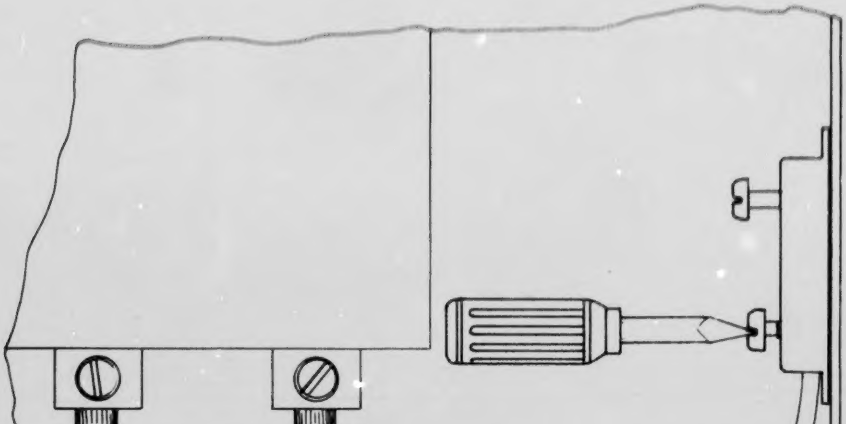


PHILLIPS HEAD SCREWDRIVER
TIGHTENING SCREWS ON HEATER COILS

TYPE

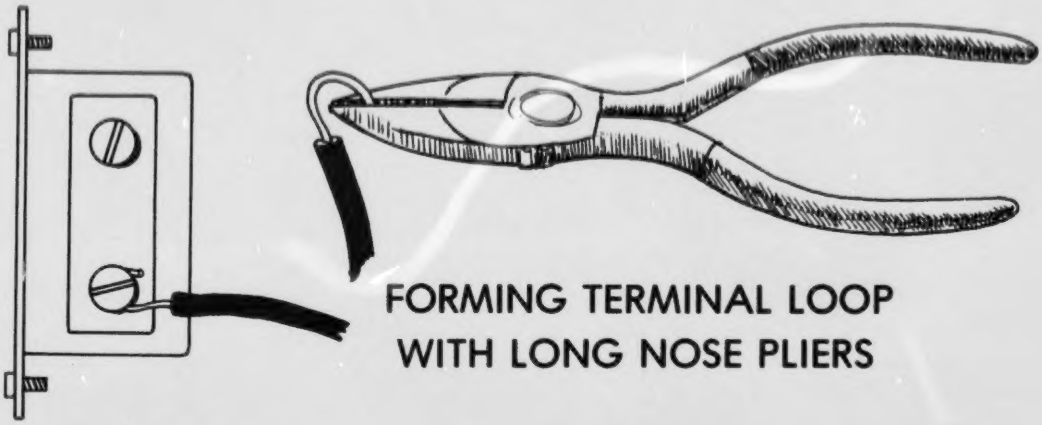


SCREW HEAD

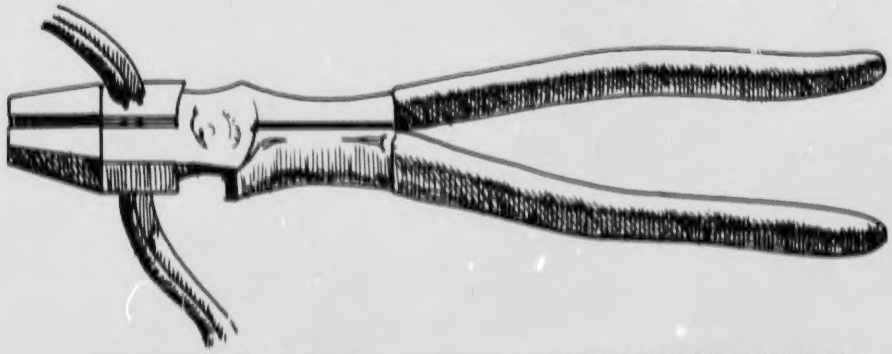


STUBBY SCREWDRIVER TIGHTENING A LUG IN LIMITED WORKING SPACE

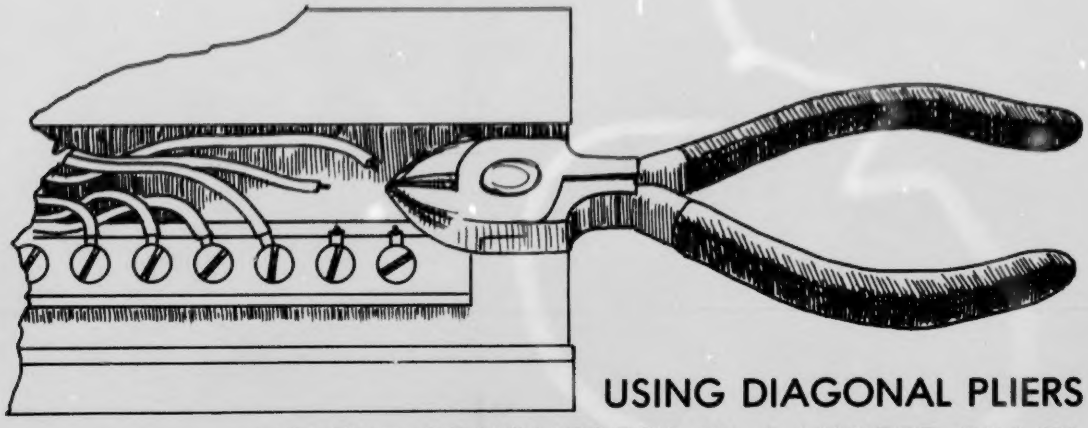
PLIERS



FORMING TERMINAL LOOP
WITH LONG NOSE PLIERS

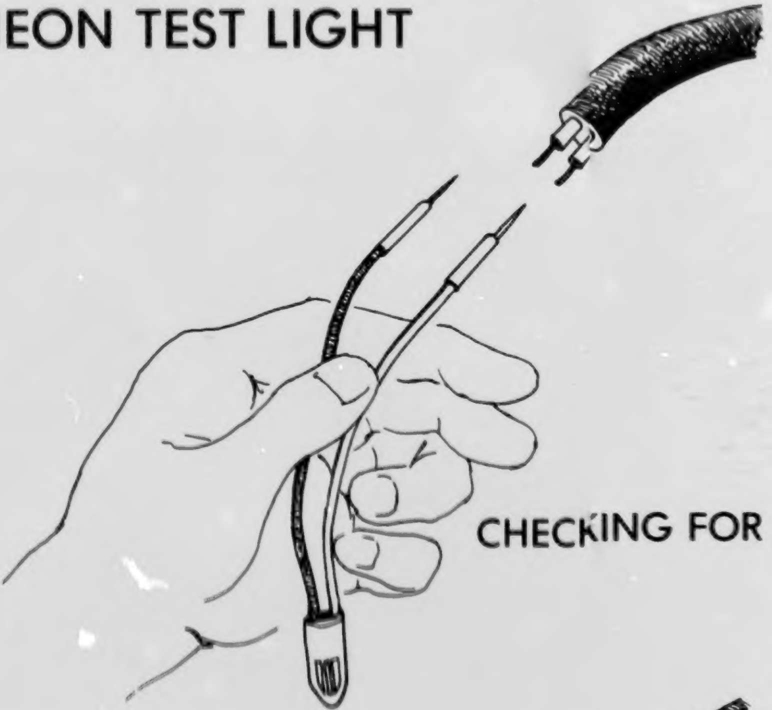


CUTTING CABLE WITH LINEMAN'S PLIERS

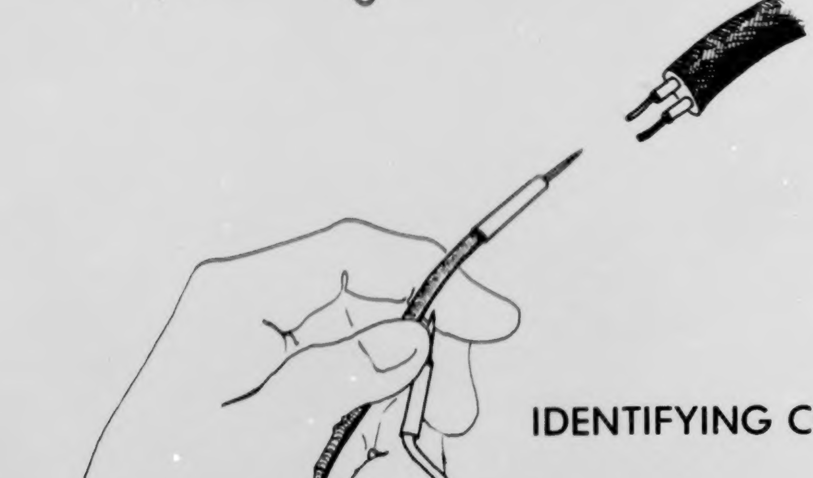


USING DIAGONAL PLIERS
TO CUT CONDUCTORS IN A LIMITED SPACE

NEON TEST LIGHT



CHECKING FOR LIVE CIRCUITS



IDENTIFYING CONDUCTORS

POUCH TOOLS
UNIT I

JOB SHEET #1--CUT CABLE USING LINEMAN'S PLIERS

I. Tools and equipment

   A. Lineman's pliers

   B. Length of cable

   (NOTE: Since 12-2G is the most commonly used cable in residential wiring you will probably want to use it.)

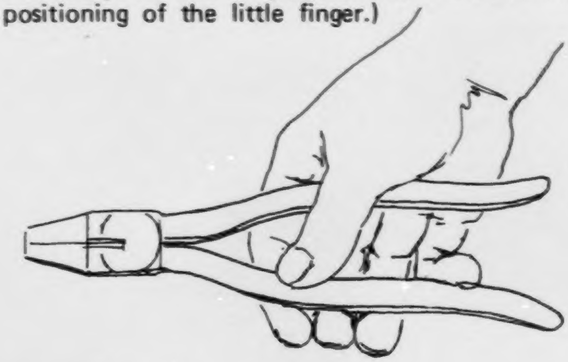
   C. Safety glasses

II. Procedure

   A. Put on safety glasses

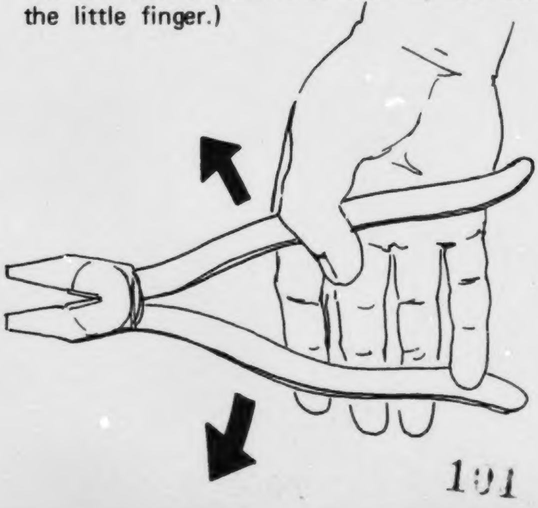
   B. Pick up pliers (Figure 1)

   (NOTE: Possibly the most important lesson to be learned in this job sheet is the positioning of the little finger.)



   C. Open cutter jaw (Figure 2)

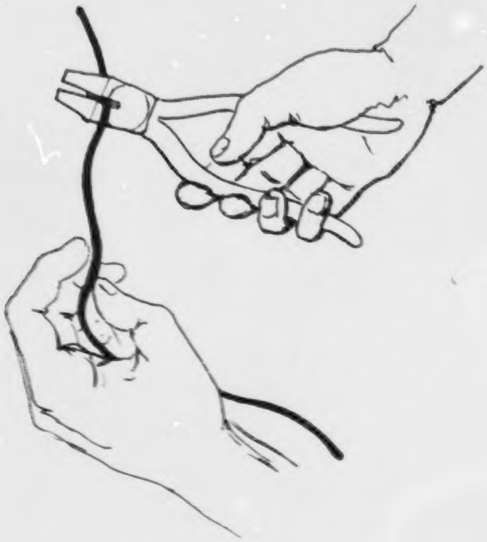
   (NOTE: One handle is secured by the thumb, the other is pushed with the little finger.)



JOB SHEET #1

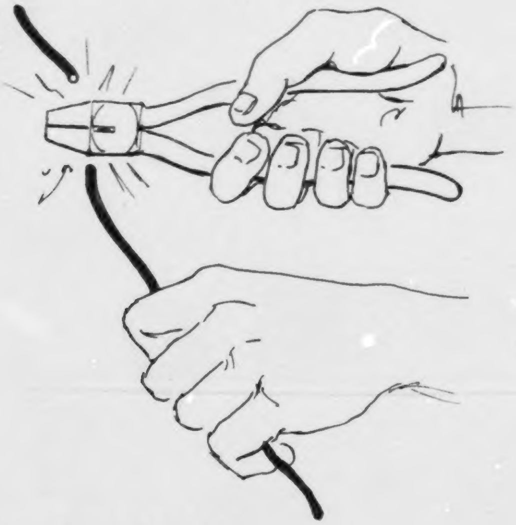
D. Put wire into the cutting jaws (Figure 3)

(NOTE: The little finger is now on outside of plier handle ready to apply leverage.)



E. Cut off the piece of cable (Figure 4)

(NOTE: Eventually reflex action will cause the little finger to reposition itself to Figure 1 position after cutting action.)



F. Repeat process until proficient

POUCH TOOLS
UNIT I

JOB SHEET #2--CLEAN AND LUBRICATE PLIERS

I. Tools and equipment

- A. Pliers
- B. Solvent
- C. Oil
- D. Solvent tray

  (NOTE: An old rectangular cake pan works well.)

II. Procedure

- A. Lay pliers in tray
- B. Pour solvent in until pliers are submersed (Figure 1)

  (NOTE: If pliers are equipped with cushion grips, only the head should be immersed.)

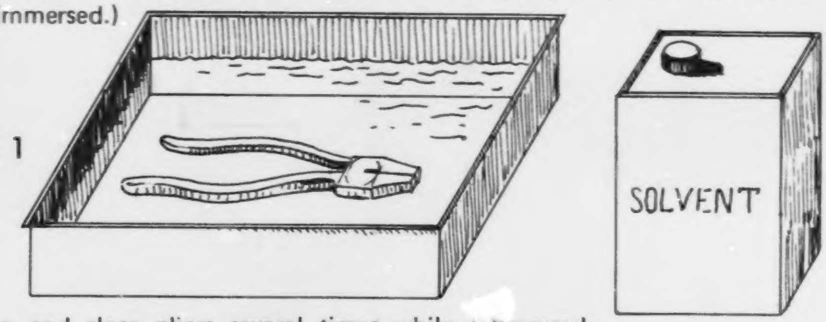


FIGURE 1

- C. Open and close pliers several times while submersed
- D. Let pliers set for two or three minutes in solvent
- E. Remove from solvent
- F. Open and close rapidly until pliers work freely

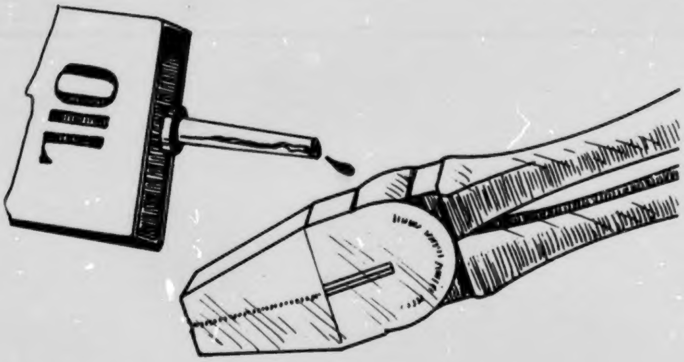
  (NOTE: If pliers are not working freely yet, repeat steps C, D, E, and F.)

- G. Wipe residue from plier joints with a cloth

JOB SHEET #2

H. Apply a couple of drops of oil to joints and work until oil has penetrated (Figure 2)

FIGURE 2



I. Wipe excess oil from pliers

POUCH TOOLS
UNIT I

JOB SHEET #3--GRIND A FLAT BLADE SCREWDRIVER

I. Tools and equipment

- A. Flat tip screwdriver
- B. Bench grinder with adjustable tool rest
- C. Water tray
- D. Safety goggles or a grinding shield that covers your face

  (NOTE: Even if a guard is provided, more protection than safety glasses is recommended.)

II. Procedure

- A. Put on shield or goggles
- B. Adjust clearance of tool rest

  (NOTE: Proper clearance is approximately one-eighth of an inch from the grinding wheel.)
- C. Turn on grinder
- D. Grind the tip of the blade flat (Figure 1)

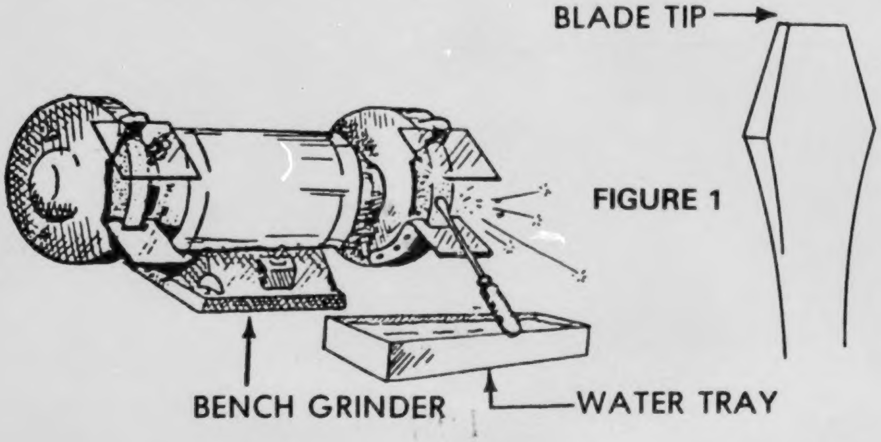


FIGURE 1

JOB SHEET #3

E. Turn off grinder and let it come to a complete stop

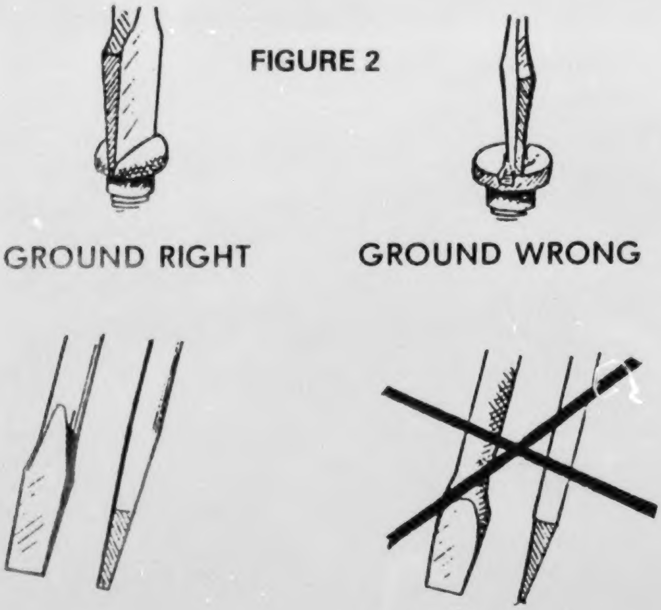
(CAUTION: Do not press any objects against the wheel to help it slow down.)

F. Readjust tool rest so that uniform grinding will occur on the flat part of the blade about one inch up the shank

G. Grind the bevel evenly on both sides until correct blade fit is reached (Figure 2)

(NOTE: Tip should be cooled frequently during grinding process to maintain metal temper.)

FIGURE 2



H. Turn off grinder and let it come to rest before leaving it

POUCH TOOLS
UNIT I

JOB SHEET #4--ADJUST WIRE STRIPPERS

I. Tools and equipment

   A. Adjustable wire strippers

   B. 12 or 14 gauge solid insulated conductor

   (NOTE: The strippers should be adjusted for stripping the most commonly used conductor in your area.)

   C. Screwdriver or nut driver to fit adjustment screw

II. Procedure

   A. Loosen adjustment screw (Figure 1)

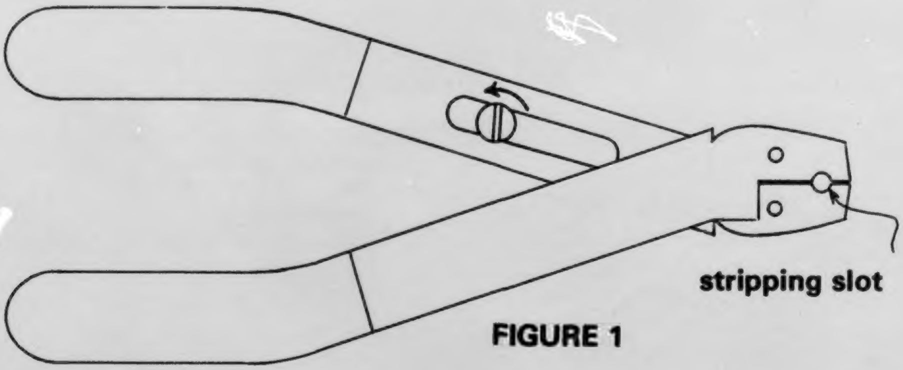


FIGURE 1

   B. Insert conductor in stripping slot

   C. Close jaws until you feel that you have reached the conductor

   D. Open the jaws slightly

JOB SHEET #4

E. Slide the adjustment screw down to its resting position (Figure 2)

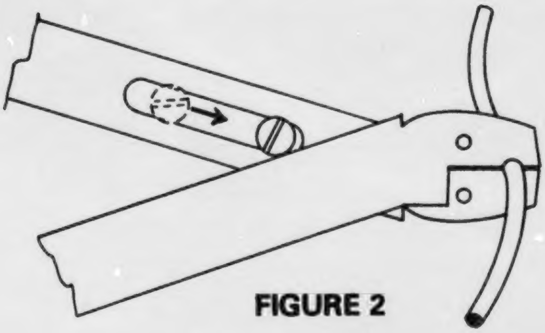


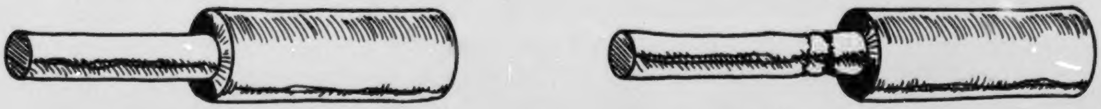
FIGURE 2

F. Strip off a fresh piece of insulation

G. Check conductor for ring or nick (Figure 3)

(NOTE: If nick occurs loosen adjustment screw, move it back slightly, retighten, and test again until insulation is cut without conductor damage.)

FIGURE 3



correctly adjusted

incorrectly adjusted

POUCH TOOLS
UNIT I

JOB SHEET #5--TRIM CONDUCTOR INSULATION USING A KNIFE

I. Tools and equipment

   A. Pocket knife

   B. Insulated conductor

   C. Safety glasses

II. Procedure

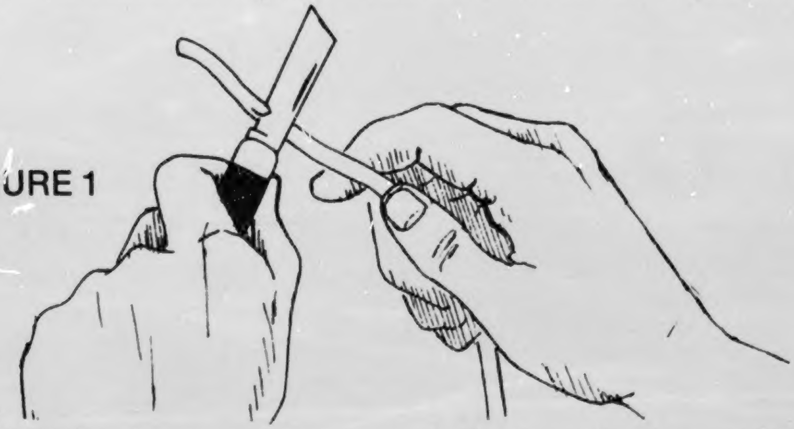
   A. Put on safety glasses

   B. Grasp pocket knife

   C. Pick up the conductor

   D. Place knife blade on length of insulation to be removed (Figure 1)

FIGURE 1

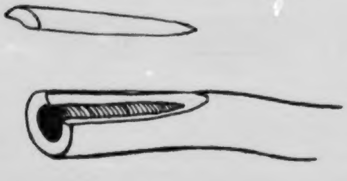


(CAUTION: Never cut toward yourself when trimming conductor insulation.)

   E. Push knife through stroke to remove chip (Figure 2)

(NOTE: Be careful and do not nick your conductor in this process.)

FIGURE 2



JOB SHEET #5

F. Rotate the conductor

G. Remove another chip (Figure 3)

(NOTE: Try to start all knife strokes evenly.)

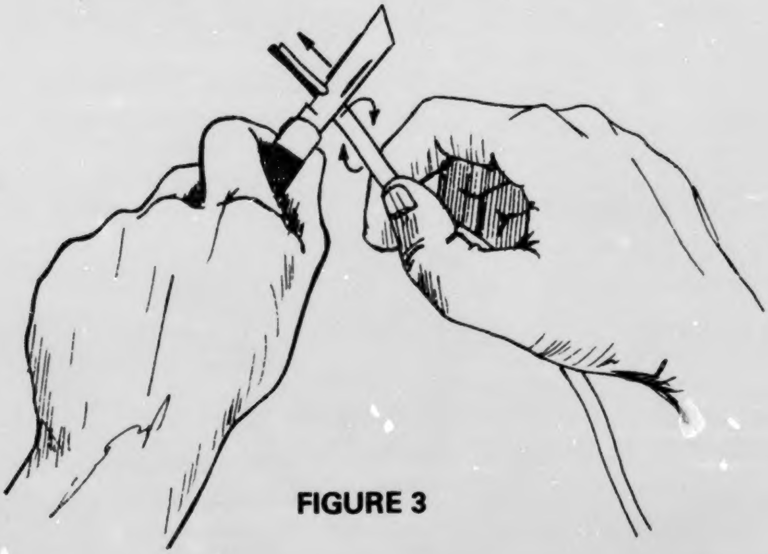


FIGURE 3

H. Rotate and trim until insulation is removed (Figure 4)

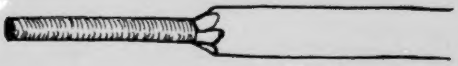


FIGURE 4

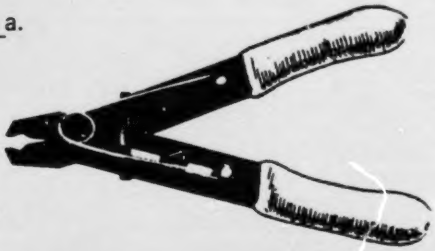
POUCH TOOLS
UNIT I

NAME ____________________________

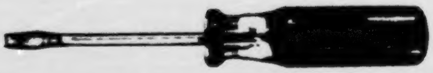
TEST

1. Match the tool names on the right to the appropriate pictures.

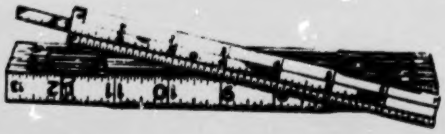
_____a.



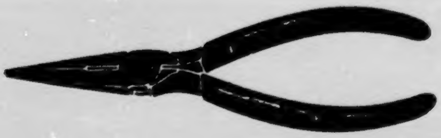
_____b.



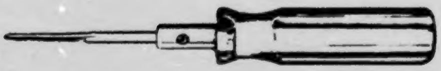
_____c.



_____d.

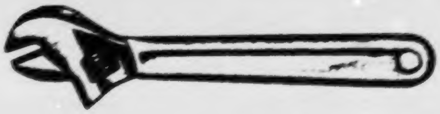


_____e.

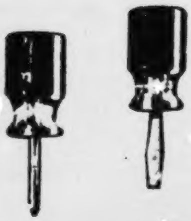


1. Folding rule with sliding scale
2. Tap tool
3. Adjustable wrench
4. Flat blade screwdriver
5. Phillips head screwdriver
6. Stubby screwdrivers
7. Adjustable wire strippers
8. Long nose pliers

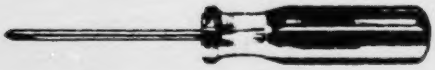
______f.



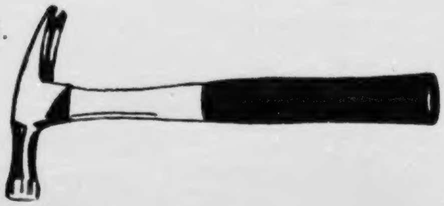
______g.



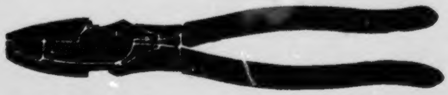
______h.



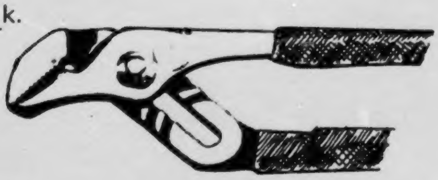
______i.



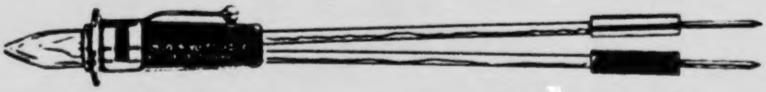
______j.



______k.



______l.



9. Lineman's pliers (side cutters)

10. Diagonal pliers

11. Groove joint pliers

12. Pocket knife

13. Electrician's hammer

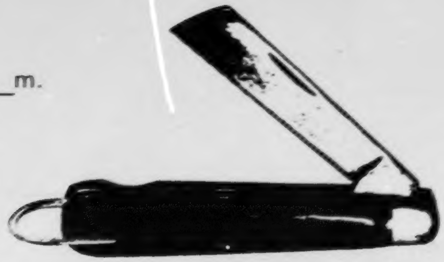
14. Tool pouch

15. Neon test light

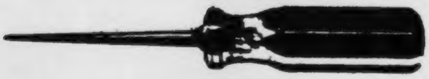
16. Awl

17. Six in one tool

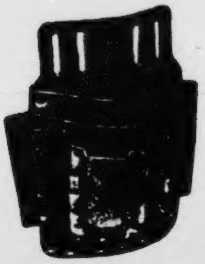
______m.



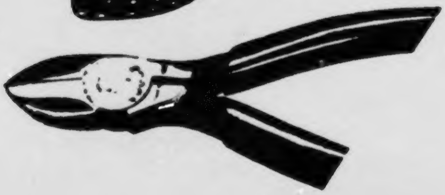
______n.



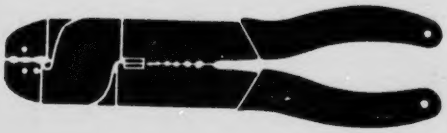
______o.



______p.



______q.



2. Match the tools on the right to their common trade uses.

_____a.
1) Measuring distances on prints
2) Locating boxes
3) Determining depth and setout

_____b.
1) Tapping drill holes for securing equipment to metal
2) Enlarging holes and tapping for larger screw
3) Retapping damaged threads
4) Determining screw sizes

_____c.
1) Removing and installing screws in limited working space
2) Tightening and loosening lugs in limited working space

_____d.
1) Cutting cables and conductors
2) Cutting small screws
3) Stripping conductors
4) Forming large conductors
5) Pulling and holding conductors

_____e.
1) Opening cartons
2) Stripping large conductors and cables

_____f.
1) Driving and pulling nails
2) Prying boxes loose
3) Chipping wood
4) Breaking plasterboard

_____g.
1) Cutting cables and conductors in limited space
2) Stripping conductors

_____h.
1) Forming small conductors
2) Stripping conductors
3) Cutting conductors
4) Holding and pulling on conductors

____ i.
1) Holding and tightening couplings and connectors
2) Holding and turning conduits and tubing

_____j.
1) Checking for live circuits
2) Identifying conductors

_____k.
1) Starting holes for screws
2) Making drill starts

1. Stubby screwdrivers
2. Lineman's pliers (side cutters)
3. Diagonal pliers
4. Electrician's hammer
5. Folding rule with sliding scale
6. Pocket knife
7. Tap tools
8. Neon test light
9. Adjustable wrench
10. Phillips head screwdriver
11. Long nose pliers
12. Flat blade screwdrivers
13. Awl
14. Adjustable wire strippers
15. Groove joint pliers
16. Six in one tool

_____l. 1) Tightening couplings and connectors
2) Tightening pressure type wire connectors
3) Removing and holding nuts

_____m. 1) Stripping insulation from conductors
2) Cutting conductors
3) Forming conductors

_____n. 1) Removing and installing phillips head screws
2) Tightening and loosening phillips head lugs

_____o. 1) Removing and installing slot head screws
2) Tightening and loosening slot head lugs

_____p. 1) Stripping insulation
2) Cutting conductors
3) Cutting small bolts

3. List four factors that should be considered when selecting tools and pouches.

a.

b.

c.

d.

4. List maintenance procedures for the following tools and pouches.

   a. Screwdrivers

      1)

      2)

   b. Pliers

      1)

      2)

      3)

      4)

   c. Adjustable wrench--

   d. Wood chisels--

   e. Tool pouches--

   f. All tools--

5. Demonstrate the ability to:

   a. Cut cable using lineman's pliers.

   b. Clean and lubricate pliers.

   c. Grind a flat blade screwdriver.

   d. Adjust wire strippers.

   e. Trim conductor insulation using a knife.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

POUCH TOOLS
UNIT I

ANSWERS TO TEST

1. a. 7
   b. 4
   c. 1
   d. 8
   e. 2
   f. 3
   g. 6
   h. 5
   i. 13
   j. 9
   k. 11
   l. 15
   m. 12
   n. 16
   o. 14
   p. 10
   q. 17

2. a. 5
   b. 7
   c. 1
   d. 2
   e. 6
   f. 4
   g. 3
   h. 11
   i. 15
   j. 8
   k. 13
   l. 9
   m. 14
   n. 10
   o. 12
   p. 16

3. Any four of the following:
   a. Tool size should be matched to the work most frequently encountered
   b. Tools should be specifically designed for electrical use when possible
      1) Should have insulation on handles of cutting pliers
      2) Should have straight claws on hammers
   c. Purchasing quality tools can save replacement costs
   d. Know the specifications before purchasing a tool
   e. Buy a pouch with enough space for the tools you will carry
      1) Helps keep tools organized
      2) Insures that you will be able to carry needed working tools

4. a. Screwdrivers
    1) Regrind worn or damaged flat blade screwdrivers
    2) Discard phillips screwdrivers with damaged heads
   b. Pliers
    1) Keep pliers clean and rust free
    2) Keep cutting edges sharp and smooth
    3) Keep pliers working freely
    4) Repair or replace damaged handle insulation
   c. Adjustable wrench--Keep worm gears clean and lubricated
   d. Wood chisels--Keep cutting edge sharp and even
   e. Tool pouches--Keep oiled, clean, and soft
   f. All tools--Identify tools by labeling them with an electric pencil or scratch awl
5. Performance skills evaluated to the satisfaction of the instructor

SPECIALTY TOOLS
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify specialty tools, match specialty tools to their use and discuss their care. The student should also be able to use soldering irons, hacksaws, knockout punches, volt ohmmeters, and ammeters. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Identify specialty tools used in residential wiring.
2. Match specialty tools to the correct uses.
3. Discuss the care of specialty tools.
4. Demonstrate the ability to:
    a. Use a soldering gun to splice conductors.
    b. Set up and use a hacksaw.
    c. Use a knockout punch.
    d. Use a volt ohmmeter.
    e. Use a clamp-on ammeter.
    f. Bend a 90° stub with 1/2" EMT.
    g. Ream rigid conduit.
    h. Cut rigid conduit with a pipe cutter.

SPECIALTY TOOLS
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Demonstrate uses of specialty tools.

   H. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Specialty Tools

      2. TM 2--Specialty Tools (Continued)

D. Job sheets

1. Job Sheet #1--Use a Soldering Gun to Splice Conductors
2. Job Sheet #2--Set Up and Use a Hacksaw
3. Job Sheet #3--Use a Knockout Punch
4. Job Sheet #4--Use a Volt Ohmmeter
5. Job Sheet #5--Use a Clamp-on Ammeter
6. Job Sheet #6--Bend a 90° Stub with 1/2" EMT
7. Job Sheet #7--Ream Rigid Conduit
8. Job Sheet #8--Cut Rigid Conduit with a Pipe Cutter

E. Test

F. Answers to test

II. References:

A. *Klein Tools and Safety Equipment*, Catalog 120. Chicago, Illinois: Klein Tools Inc.

B. *Grangers Wholesale Net Price Motorbook*, No. 345. Oklahoma City, Oklahoma: W. W. Grangers Inc., 1976.

C. *Greenlee Catalog*, No. 47. Rockford, Illinois: Greenlee Tool Co.

D. *Holub Catalog*, No. 23. Sycamore, Illinois: ITT Holub Industries, 1976.

SPECIALTY TOOLS
UNIT II

INFORMATION SHEET

I. Specialty tools (Transparencies 1 and 2)

   A. Soldering gun

      (NOTE: Soldering irons are also sometimes used.)

   B. Hacksaw

   C. Brace

   D. Drill motor

   E. Knockout punch

   F. Keyhole saw

   G. Fish tape and reel

   H. Drop chain

   I. Reciprocal saw

   J. Volt ohmmeter

   K. Ammeter

   L. Hickey bender

   M. Torpedo level

   N. Plumb bob

   O. EMT (electrical metallic tubing) bender

   P. Files

   Q. Chisel

   R. Ship auger bit

   S. Pipe reamer

   T. Pipe cutter

INFORMATION SHEET

II. Specialty tools and their uses

- A. Soldering gun
    - 1. Splicing conductors
    - 2. Unsplicing soldered conductors
- B. Hacksaw
    - 1. Cutting EMT
    - 2. Cutting pipe
    - 3. Cutting large conductors or cables
- C. Brace--Boring holes for cables or conduits manually
- D. Drill motor--Boring holes for cables or conduits when electricity is available
- E. Knockout punches
    - 1. Cutting holes for cable or conduit fittings in metal boxes, equipment, or appliances
    - 2. Enlarging holes in metal boxes, equipment, or appliances
- F. Keyhole saw
    - 1. Cutting holes in plasterboard or paneling for boxes
    - 2. Cutting exposed lath for box installation
- G. Fish tape and reel
    - 1. Pulling wires or cables through EMT or pipe
    - 2. Pulling cables up insulated walls
- H. Drop chain--Pulling cables in walls
- I. Reciprocal saw
    - 1. Flush cutting pipes, boards, or fasteners
    - 2. Cutting heavy lumber

INFORMATION SHEET

J. Volt ohmmeter

   1. Measuring circuit voltage
   2. Measuring circuit resistance
   3. Checking for circuit voltage
   4. Checking for continuity

K. Ammeter

   1. Checking circuit amperage
   2. Checking individual load amperage
   3. Checking motor starting and running current

L. Hickey bender--Bending heavy wall conduits

M. Torpedo level

   1. Leveling conduits and equipment
   2. Leveling appliances

N. Plumb bob

   1. Transferring location points from ceiling to floor or floor to ceiling
   2. Leveling conduits

O. EMT bender--Bending EMT

P. Files

   1. Deburring large conduits
   2. Sharpening tools
   3. Cutting and forming metals

Q. Chisel--Notching wood for boxes or cables

R. Pipe reamer--Deburring conduits

S. Pipe cutter--Cutting conduit

INFORMATION SHEET

III. Care of specialty tools

   A. Electrically powered tools

      (NOTE: This includes soldering irons, drill motors and reciprocal saws.)

      1. Replace damaged cords or attachment caps on electrical tools
      2. Keep movable parts properly lubricated
      3. Keep tools in proper storage cases or locations
      4. Keep tools clean
      5. Use only for intended purposes
      6. Keep all attachments sharp and in good condition

   B. Forming and cutting tools

      (NOTE: This includes hacksaws, knockout punches, keyhole saws, files, chisels, and bits.)

      1. Keep all cutting edges properly protected
      2. Keep all cutting edges sharp and in good condition
      3. Use only for intended purposes
      4. Keep clean

   C. Meters

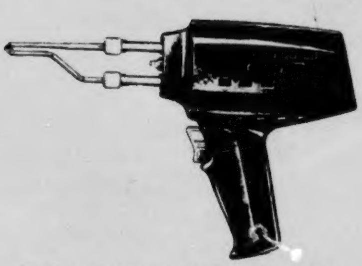
      1. Keep stored in proper cases
      2. Avoid bumping or jolting
      3. Use only for intended purposes
      4. Use within meter range limits
      5. Avoid exposure to extreme temperature
      6. Keep clean
      7. Keep dry

INFORMATION SHEET

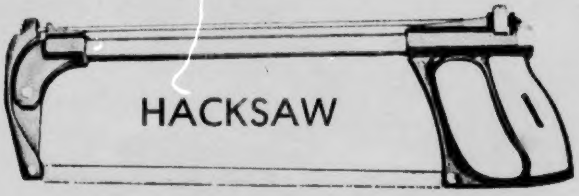
D. Other specialty tools

1. Repair or replace damaged parts
2. Use only for intended purposes
3. Keep clean

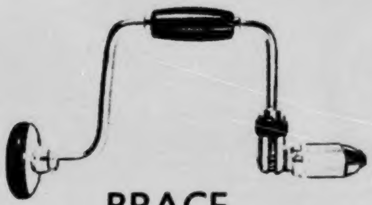
SPECIALTY TOOLS



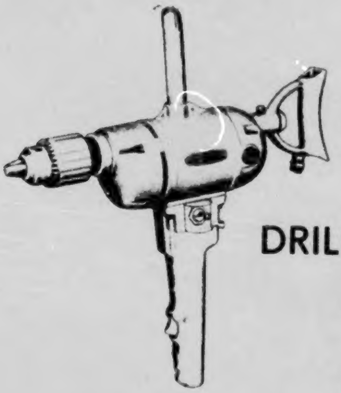
SOLDERING GUN



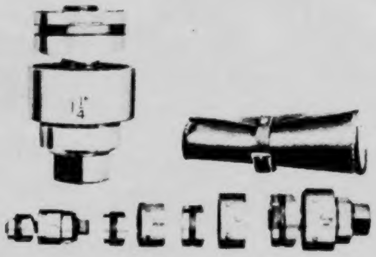
HACKSAW



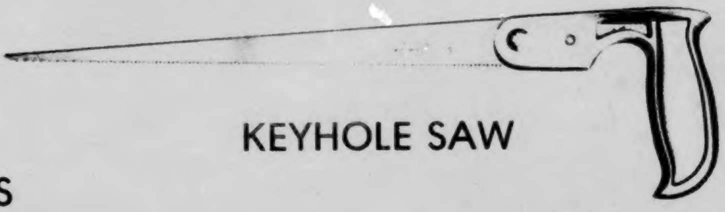
BRACE



DRILL MOTOR

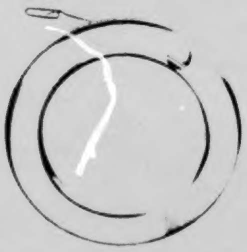


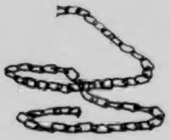
KNOCKOUT PUNCHES



KEYHOLE SAW

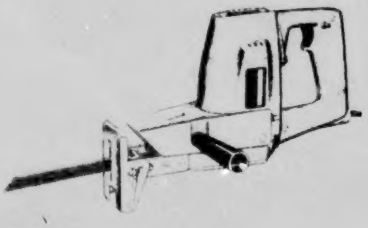
FISH TAPE AND REEL

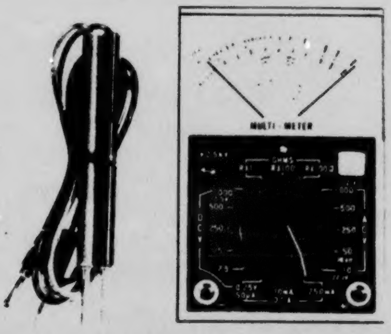




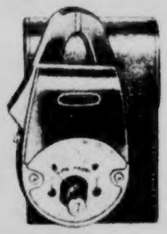
DROP CHAIN

RECIPROCAL SAW



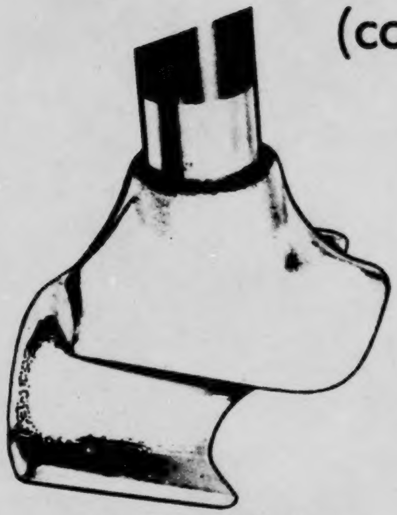


VOLT OHMMETER

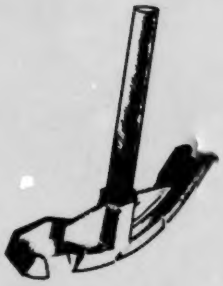


AMMETER

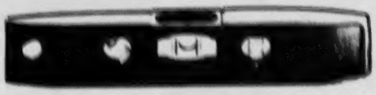
SPECIALTY TOOLS
(continued)



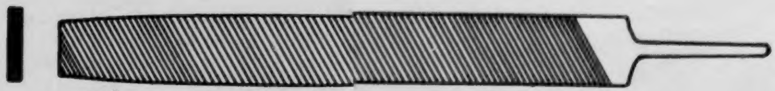
HICKEY BENDER



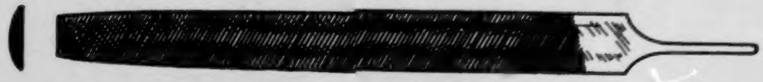
EMT BENDER



TORPEDO LEVEL

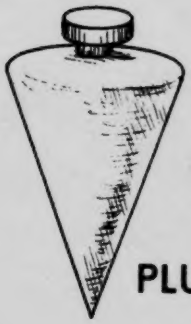


Flat

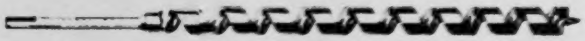


Half Round

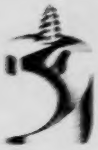
FILES

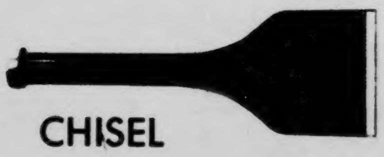


PLUMB BOB

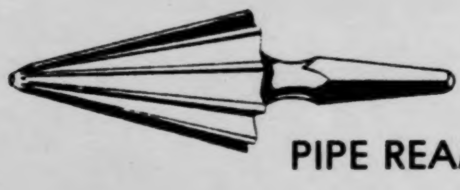


SHIP AUGER BIT

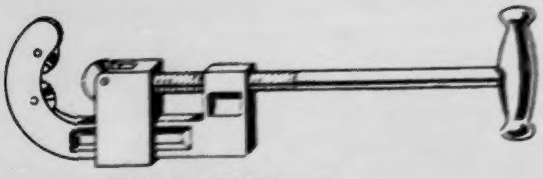




CHISEL



PIPE REAMER



PIPE CUTTER

SPECIALTY TOOLS
UNIT II

JOB SHEET #1--USE A SOLDERING GUN TO SPLICE CONDUCTORS

I. Tools and equipment

- A. Soldering gun
- B. Lineman's pliers
- C. Wire strippers
- D. Safety glasses
- E. Rosin core solder

  (NOTE: Rosin core or solder and flux are acceptable.)

- F. Two 6" pie[illegible] copper conductor

II. Procedure

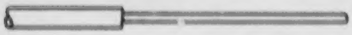
- A. Put on safety glasses
- B. Strip approximately 1" of insulation from the conductor

JOB SHEET #1

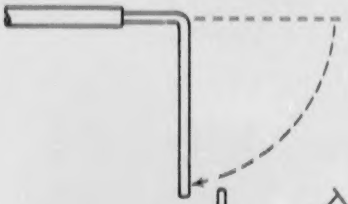
C. Form a splice (Figure 1)

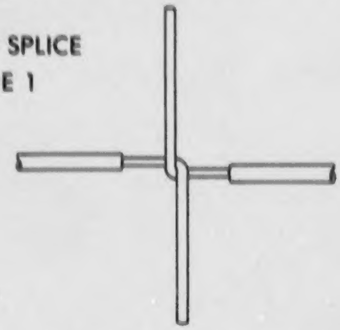
(NOTE: Any solid splice will work. Two types are illustrated here.)

STRAIGHT SPLICE
FIGURE 1

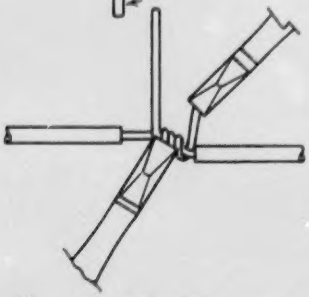


1. Bend 90° angles in both conductors

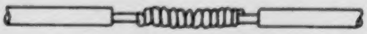




2. Hook conductors together



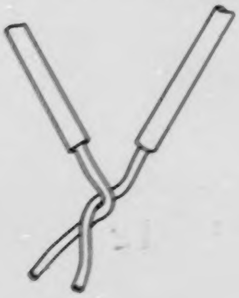
3. Hold one conductor secure while wrapping the other



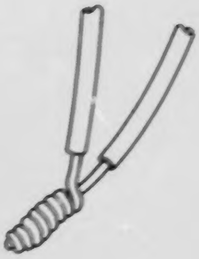
4. Finished straight splice

TWIST SPLICE (PIG TAIL)

1. Lap conductors over each other



2. Twist tightly



D. Clean tip of soldering gun

JOB SHEET #1

E. Heat gun tip

(NOTE: You can touch the solder to the gun tip to determine if it is hot enough.)

F. Put gun tip on underside of splice to heat it (Figure 2)

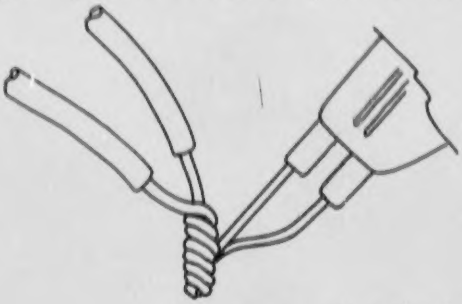


FIGURE 2

G. Apply solder to top of joint (Figure 3)

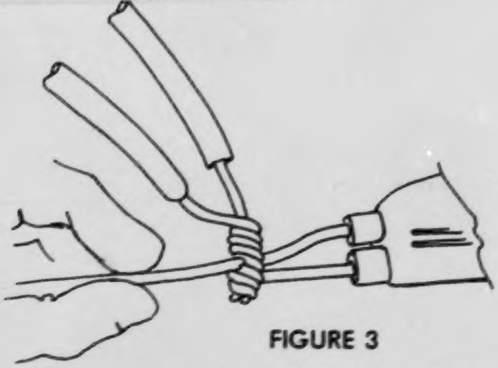


FIGURE 3

H. Remove soldering gun and solder stick from joint when it has filled

I. Have the instructor inspect the splice

J. Clean up tools and replace

SPECIALTY TOOLS
UNIT II

JOB SHEET #2--SET UP AND USE A HACKSAW

I. Tools and equipment

A. Hacksaw frame

B. Hacksaw blade

(NOTE: For cutting pipe or conduit a 24 or 32 teeth/inch blade is recommended.)

C. Pipe or conduit

D. Safety glasses

II. Procedure

A. Put on safety glasses and gather tools and equipment

B. Insert blade in frame (Figure 1)

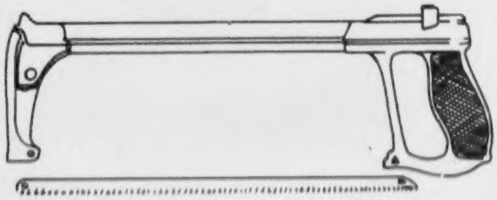


FIGURE 1

(NOTE: Be sure teeth angles are pointed toward the front of the saw. (Figure 2))

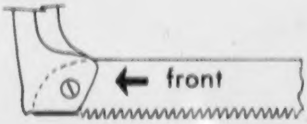


FIGURE 2

JOB SHEET #2

C. Secure pipe or conduit for cutting (Figure 3)

(NOTE: Short pieces of pipe are easier to cut in a vise.)

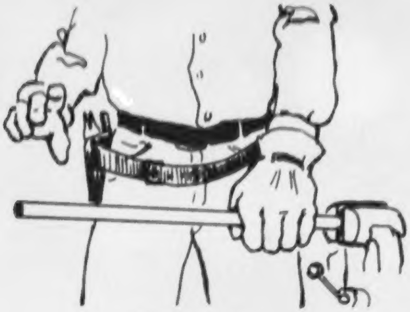


FIGURE 3

D. Rest the blade on the pipe or conduit at the point to be cut

E. Push forward gently until cut is started

(NOTE: Do not exert extra pressure on saw.)

F. Make reciprocal strokes until cut is finished

(NOTE: Excessive speed while cutting can ruin blades. You should not use over thirty full strokes per minute.)

G. Have the instructor check your cut (Figure 4)

(NOTE: Your cut should be straight and relatively smooth.)

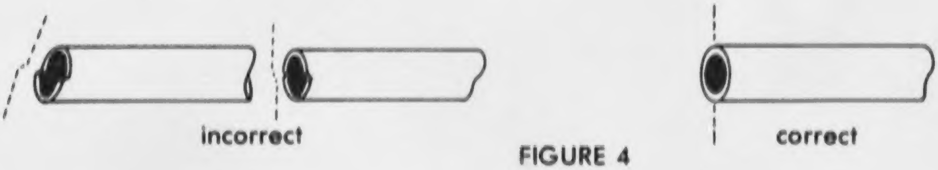


FIGURE 4

SPECIALTY TOOLS
UNIT II

JOB SHEET #3--USE A KNOCKOUT PUNCH

I. Tools and equipment

   A. Knockout punch

   B. Drill motor

   C. Metal drill

      (NOTE: Drill must be large enough to let the knockout punch screw through the opening it makes.)

   D. 10" adjustable wrench or 1/2" ratchet with socket to fit drive nut

   E. Metal to be punched

      (NOTE: Most punches are rated up to 10 gauge metal.)

   F. Vise

      (NOTE: A vise is needed if material to be cut is not fastened on a wall or is too small to stand on to hold.)

   G. Safety glasses

   H. Extension cord

II. Procedure

   A. Put on safety glasses and gather tools and equipment

   B. Drill a hole slightly larger than the KO punch bolt in the center of the space you are going to punch

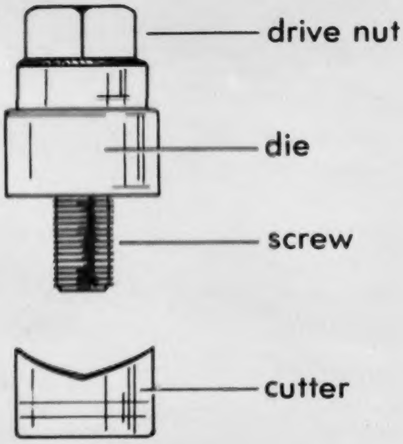
      (NOTE: A center punch should be used to make an indentation for your drill to start in.)

      (CAUTION: Hold the drill motor firmly while drilling. A loose grip could cause an accident. Remember that the drill will be hot and use caution around it until it cools.)

JOB SHEET #3

C. Separate the knockout punch cutter from the die and screw (Figure 1)

FIGURE 1



D. Insert bolt through drilled hole and put cutter back on screw (Figure 2)

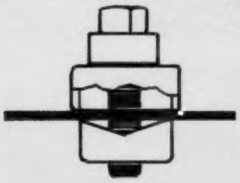


FIGURE 2

E. Tighten drive nut with wrench or socket (Figure 3)

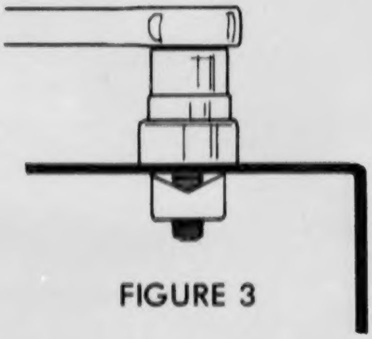


FIGURE 3

F. When cutter is finally pulled through, knockout punch is easily removed (Figure 4)

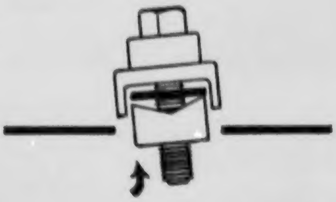
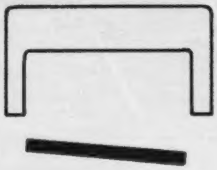


FIGURE 4

JOB SHEET #3

G. Remove cutter from screw and shake out punched metal (Figure 5)

FIGURE 5



H. Replace cutter

(NOTE: Keep cutter lubricated.)

I. Have instructor evaluate job

J. Put up tools and equipment

SPECIALTY TOOLS
UNIT II

JOB SHEET #4--USE A VOLT OHMMETER

I. Tools and equipment

   A. Volt ohmmeter

   B. Safety glasses

   C. 125 volt duplex grounding receptacle

   D. 250 volt grounding receptacle

   E. Assorted fuses

II. Procedure

   A. Read meter instructions

   (NOTE: Some meters require a specific probe connection at the meter.)

   B. Put on safety glasses

   C. Set meter at highest A.C. scale

   D. Check across grounded and ungrounded slots of 125 volt duplex grounding receptacle (Figure 1)

   (NOTE: If reading on highest scale does not exceed the next lower scale drop to it for a more accurate reading. Repeat this process until you are reading on the lowest possible scale.)

   (CAUTION: Connecting a meter that is set on a scale lower than the actual circuit voltage could damage the meter.)

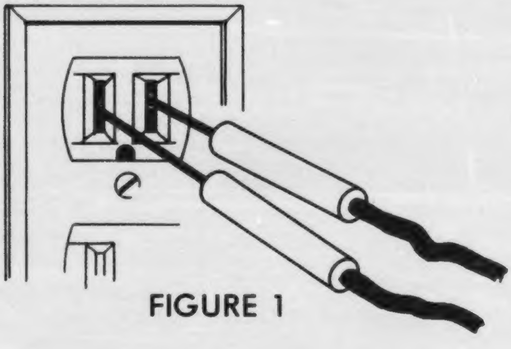


FIGURE 1

JOB SHEET #4

E. Check voltage across ungrounded (narrow slot) and grounding slot (Figure 2)

(NOTE: Again, start at the highest meter scale. A short in a multi-wire branch circuit can give a dual voltage reading in this test.)

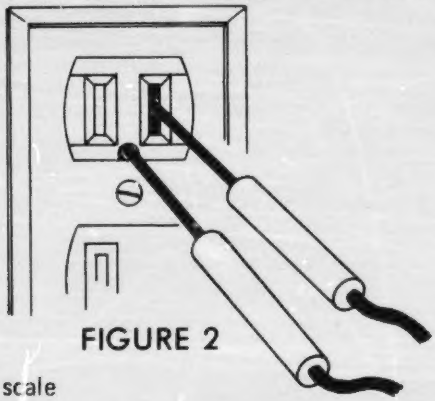


FIGURE 2

F. Reset meter to highest scale

G. Check across ungrounded slots of a 250 volt receptacle (Figure 3)

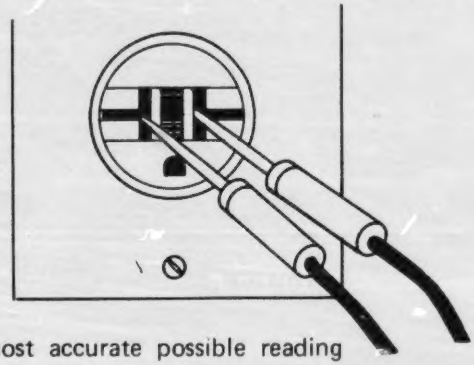


FIGURE 3

H. Reduce scale to most accurate possible reading

I. Read from each ungrounded conductor to the grounding conductor (Figure 4)

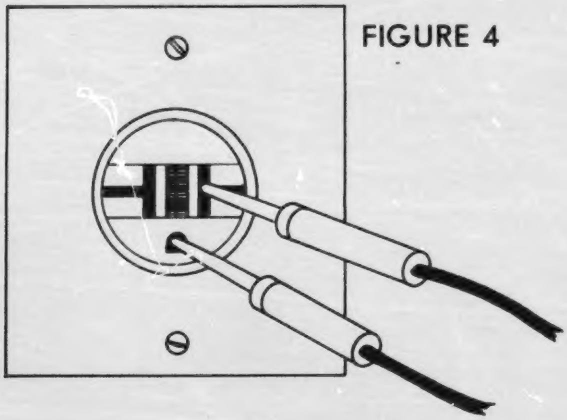


FIGURE 4

JOB SHEET #4

J. Change meter to ohm scale

K. Measure across fuse contacts for continuity (Figure 5)

(NOTE: A reading indicates that the fuse is good. No reading indicates the fuse is bad.)

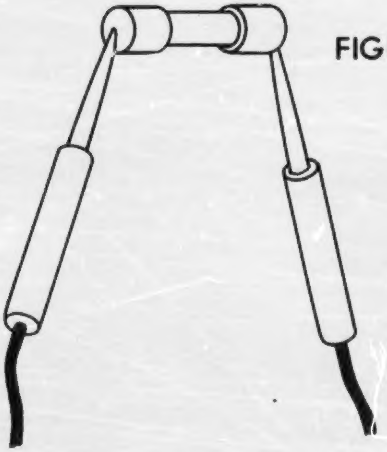


FIGURE 5

SPECIALTY TOOLS
UNIT II

JOB SHEET #5--USE A CLAMP-ON AMMETER

I. Tools and Equipment

   A. Clamp-on ammeter

   B. Electric motor

   C. Safety glasses

   (NOTE: Pouch tools may be required if your motor does not have a disconnect, magnetic starter, or some other opening to allow you to reach the individual conductors.)

II. Procedure

   A. Put on safety glasses

   B. Set ammeter on higher ampere scale if adjustable

   C. Clamp the ammeter around a single motor supply conductor (**Figure 1**)

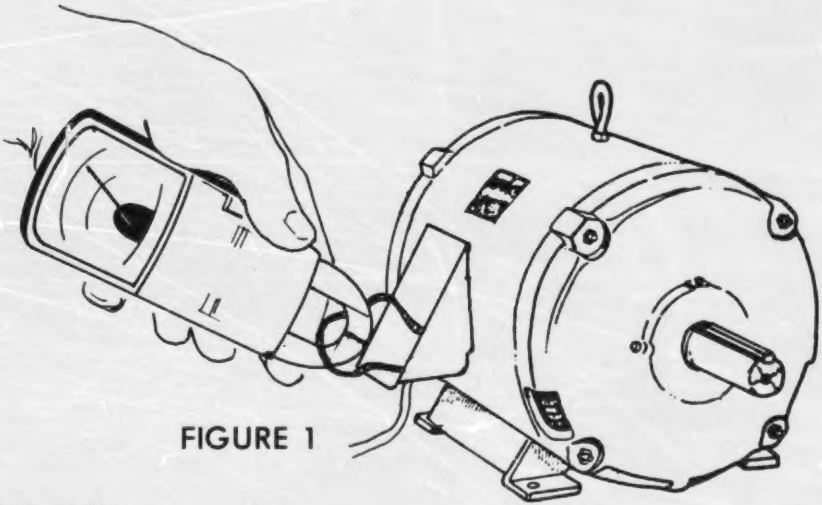


FIGURE 1

   D. Start motor

   E. Record starting amperage

   (NOTE: There will be a momentary surge in current. The highest point is starting amperage.)

   F. Allow motor to reach running speed

   G. Record running amperage

JOB SHEET #5

H. Compare with nameplate rating

I. Have instructor evaluate

J. Turn off motor

K. Put up meter and equipment

(NOTE: Always store meters in proper cases and locations.)

SPECIALTY TOOLS
UNIT II

JOB SHEET #6--BEND A 90° STUB WITH 1/2" EMT

(NOTE: Due to the differences in bender shoe markings, the height of this bend and its determination will be left to the instructor.)

I. Tools and equipment

   A. 1/2" EMT bender

   B. 1/2" EMT (length optional)

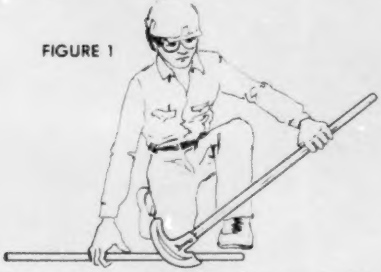
   C. Safety glasses

II. Procedure

   A. Put on safety glasses and gather tools and equipment

   B. Place the conduit in the bender jaw (Figure 1)

FIGURE 1

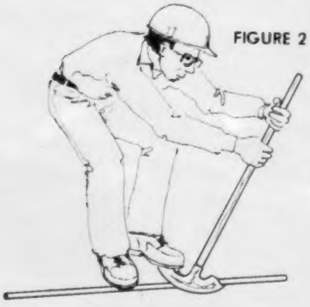


   C. Apply light pressure on handle to hold conduit in place

   D. Place one foot on bender kick pad

   E. Place other foot on conduit (Figure 2)

FIGURE 2



JOB SHEET #6

F. Apply heavy pressure on bender kick pad while pulling handle to a straight up position (Figure 3)

(NOTE: If pressure is not applied solidly to kick pad conduit can wrinkle or collapse.)

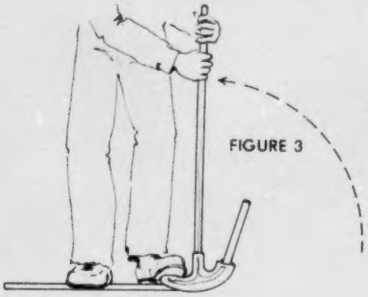


FIGURE 3

G. Reposition feet for comfort (Figure 4)

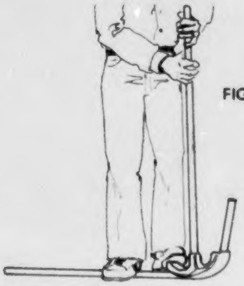


FIGURE 4

H. Reapply kick pad and bender handle pressure till bend is completed (Figure 5)

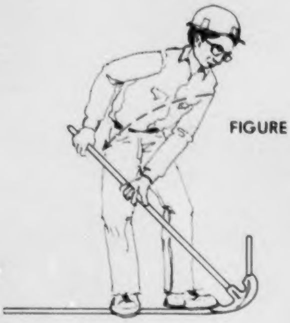


FIGURE 5

(NOTE: A square can be used to evaluate your accuracy until you develop your skills.)

SPECIALTY TOOLS
UNIT II

JOB SHEET #7--REAM RIGID CONDUIT

I. Tools and equipment

   A. Pipe vise

   B. Reamer

   (NOTE: You will need a ratchet hand or brace depending on which type reamer used.)

   C. Piece of rigid conduit

   D. Safety glasses

II. Procedure

(NOTE: Be safety conscious around cut pieces of rigid conduit. Sharp ridges or spurs can cause deep cuts.)

   A. Place conduit in vise

   B. Insert reamer tip in conduit (Figure 1)

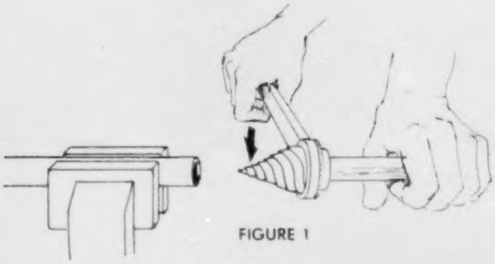


FIGURE 1

   C. Apply light forward pressure to push reamer into conduit

   D. Start rotating reamer (Figure 2)

   (NOTE: Reamer should bite instantly if proper pressure is applied. Reamer can be damaged if rotated in the wrong direction.)

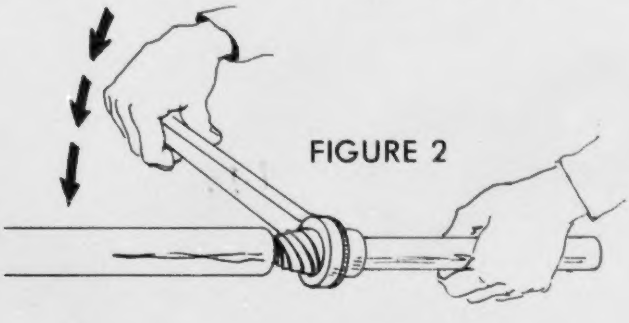


FIGURE 2

JOB SHEET #7

E. Rotate reamer until burrs are removed

(NOTE: This is a developed skill; the reamer can be pulled out and your progress inspected.)

F. Pull reamer back while continuing to rotate (Figure 3)

(NOTE: This prevents the reamer from leaving a burr.)

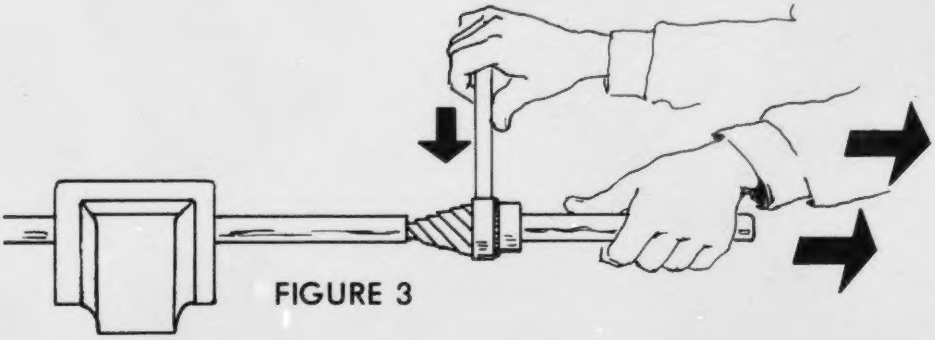


FIGURE 3

G. Have your instructor evaluate your work

H. Put up all tools and equipment

SPECIALTY TOOLS
UNIT II

JOB SHEET #8--CUT RIGID CONDUIT WITH A PIPE CUTTER

I. Tools and equipment

   A. Pipe vise

   B. Pipe cutter

   C. Rigid conduit

   D. Cutting oil

   E. Safety glasses

   F. Shop towel

   G. Pencil

II. Procedure

   A. Put on safety glasses and gather tools and equipment

   B. Secure conduit in vise

   C. Mark place for cut with pencil

   D. Open pipe cutter until it will fit over conduit

   E. Locate cutter wheel on the pencil mark (Figure 1)

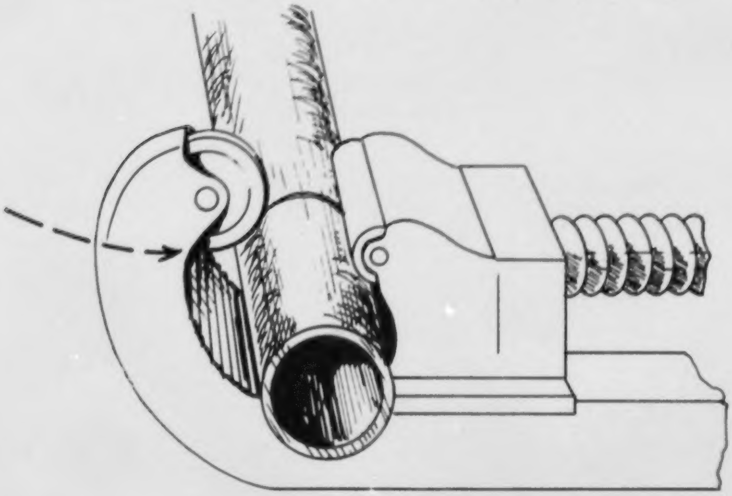


FIGURE 1

JOB SHEET #8

F. Snug cutter up to conduit by rotating screw handle (Figure 2)

(NOTE: Don't overtighten as this can break cutter wheel.)

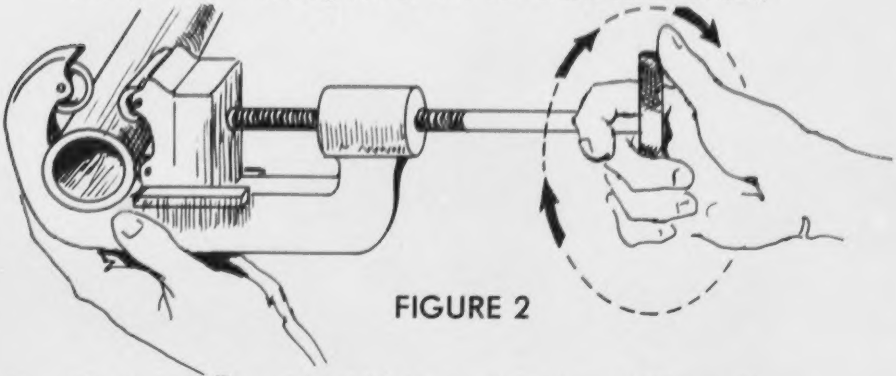
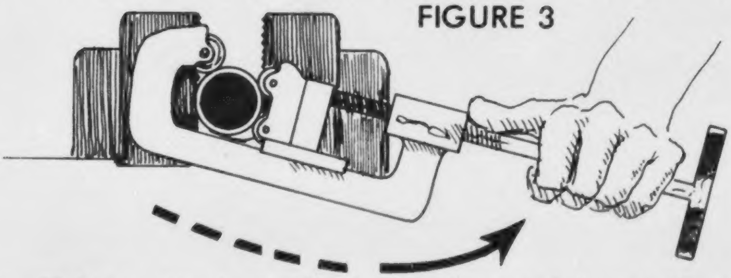


FIGURE 2

G. Rotate cutter counterclockwise to start groove (Figure 3)

FIGURE 3



H. Tighten cutter hand 1/4 of a turn for each full revolution around the pipe

(NOTE: Overtightening can cause cutters to break.)

I. Add a small amount of cutting oil to the groove

(CAUTION: When cutting short pieces of conduit be careful not to cut your arm while rotating the cutter around the pipe.)

J. Continue process until conduit is cut

(NOTE: Be prepared to catch free piece of conduit.)

K. Clean conduit and cutter with shop towel

L. Have instructor inspect work

M. Put up tools and equipment

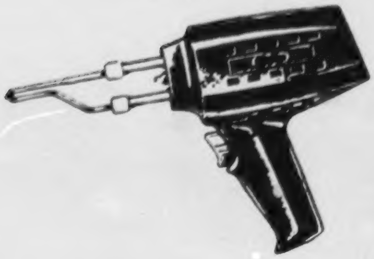
N. Clean up work area

SPECIALTY TOOLS
UNIT II

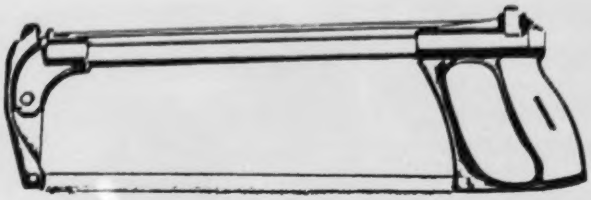
NAME ______________________

TEST

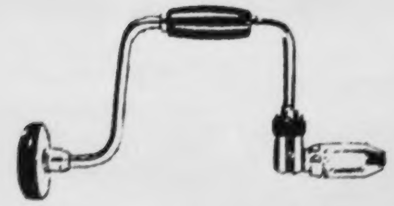
1. Identify the specialty tools used in residential wiring.



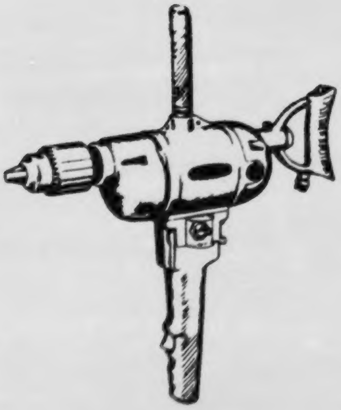
a. ______________________



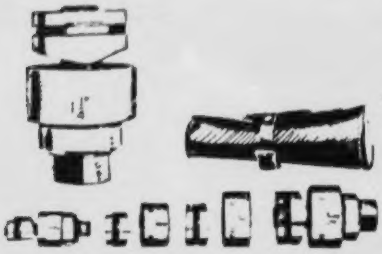
b. ______________________



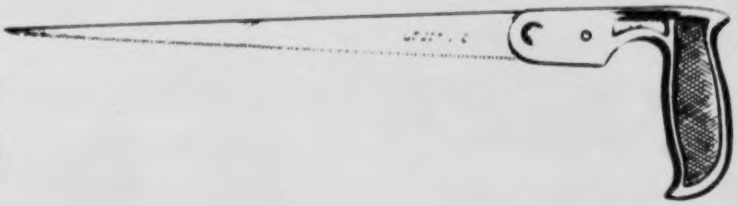
c. ______________________



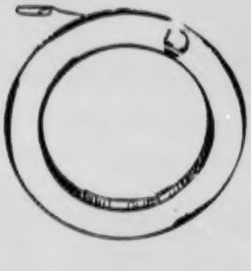
d. ______________________

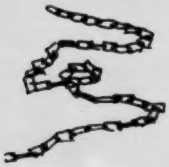


e. ______________________



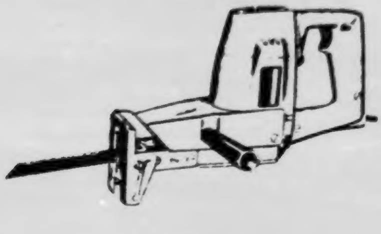
f. ______________________



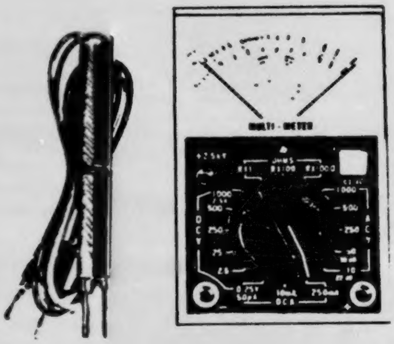


g.

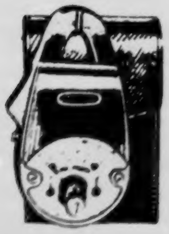
h.



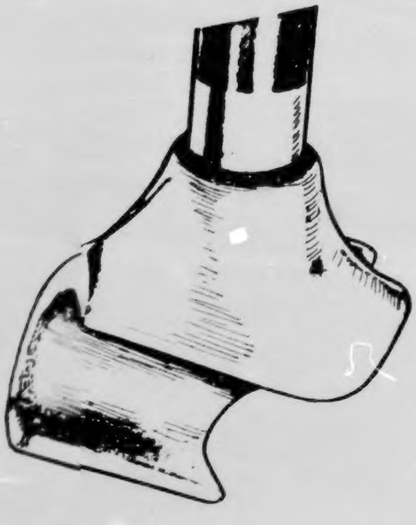
i.

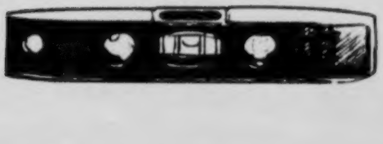

MULTI - METER

j.



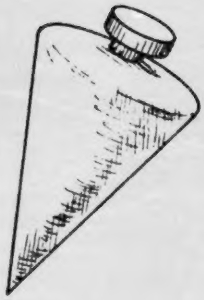
k.



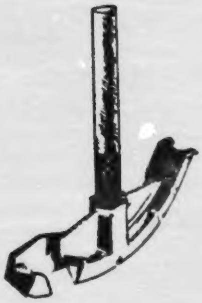


l.

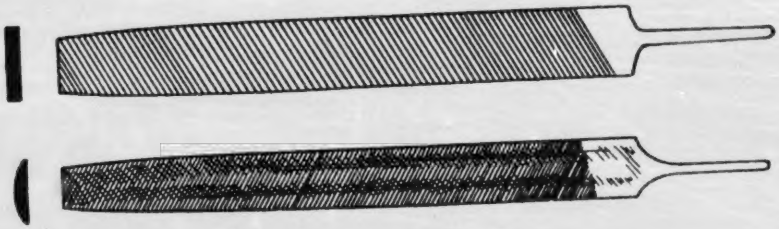
m.



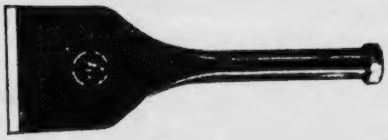
n. ____________________



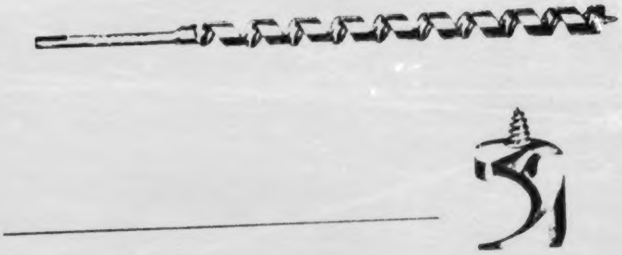
o. ____________________



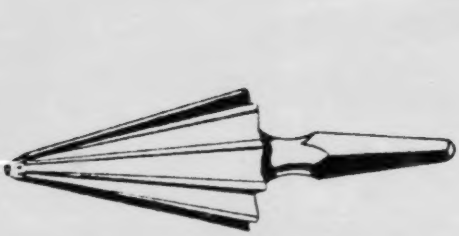
p. ____________________



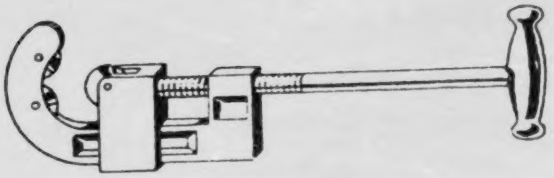
q. ____________________



r. ____________________



s. ____________________



t. ____________________

2. Match the specialty tools on the right to the correct uses.

_____a. 1) Cutting holes in plasterboard or paneling for boxes
    2) Cutting exposed lath for box installation

_____b. Pulling cables in walls

_____c. Boring holes for cables or conduits when electricity is available

_____d. 1) Splicing conductors
    2) Unsplicing soldered conductors

_____e. Boring holes for cables or conduits manually

_____f. 1) Pulling wires or cables through EMT or pipe
    2) Pulling cables up insulated walls

_____g. Bending EMT

_____h. Notching wood for boxes or cables

_____i. 1) Measuring circuit voltage
    2) Measuring circuit resistance
    3) Checking for circuit voltage
    4) Checking for continuity

_____j. 1) Cutting EMT
    2) Cutting pipe
    3) Cutting large conductors or cables

_____k. 1) Flush cutting pipes, boards, or fasteners
    2) Cutting heavy lumber

_____l. 1) Cutting holes for cable or conduit fittings in metal boxes, equipment, or appliances
    2) Enlarging holes in metal boxes, equipment, or appliances

_____m. 1) Leveling conduits and equipment
    2) Leveling appliances

_____n. 1) Deburring large conduits
    2) Sharpening tools
    3) Cutting and forming metals

1. Brace
2. Reciprocal saw
3. Soldering gun
4. Fish tape and reel
5. Hickey bender
6. Files
7. Volt ohmmeter
8. Knockout punches
9. Drill motor
10. Ammeter
11. EMT bender
12. Chisel
13. Hacksaw
14. Drop chain
15. Keyhole saw
16. Plumb bob
17. Torpedo level
18. Pipe reamer
19. Pipe cutter

_____o. Bending heavy wall conduits

_____p. 1) Transferring location points from ceiling to floor or floor to ceiling
    2) Leveling conduits

_____q. 1) Checking circuit amperage
    2) Checking individual load amperage
    3) Checking motor starting and running current

_____r. Deburring conduits

_____s. Cutting conduit

3. Discuss the care of specialty tools.

    a. Electrically powered tools

    b. Forming and cutting tools

    c. Meters

d. Other specialty tools

4. Demonstrate the ability to:

    a. Use a soldering gun to splice conductors.

    b. Set up and use a hacksaw.

    c. Use a knockout punch.

    d. Use a volt ohmmeter.

    e. Use a clamp-on ammeter

    f. Bend a 90° stub with 1/2" EMT

    g. Ream rigid conduit

    h. Cut rigid conduit with a pipe cutter

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

SPECIALTY TOOLS
UNIT II

ANSWERS TO TEST

1. a. Soldering gun
   b. Hacksaw
   c. Brace
   d. Drill motor
   e. Knockout punch
   f. Keyhole saw
   g. Fish tape and reel
   h. Drop chain
   i. Reciprocal saw
   j. Volt ohmmeter
   k. Ammeter
   l. Hickey bender
   m. Torpedo level
   n. Plumb bob
   o. EMT (electrical metallic tubing) bender
   p. Files
   q. Chisel
   r. Ship auger bit
   s. Pipe reamer
   t. Pipe cutter
2. a. 15
   b. 14
   c. 9
   d. 3
   e. 1

f. 4

g. 11

h. 12

i. 7

j. 13

k. 2

l. 8

m. 17

n. 6

o. 5

p. 16

q. 10

r. 18

s. 19

3. Discussion should include:

   a. Electrically powered tools

      1) Replace damaged cords or attachment caps on electrical tools

      2) Keep movable parts properly lubricated

      3) Keep tools in proper storage cases or locations

      4) Keep tools clean

      5) Use only for intended purposes

      6) Keep all attachments sharp and in good condition

   b. Forming and cutting tools

      1) Keep all cutting edges properly protected

      2) Keep all cutting edges sharp and in good condition

      3) Use only for intended purposes

      4) Keep clean

c. Meters

   1) Keep stored in proper cases

   2) Avoid bumping or jolting

   3) Use only for intended purposes

   4) Use within meter range limits

   5) Avoid exposure to extreme temperature

   6) Keep clean

   7) Keep dry

d. Other specialty tools

   1) Repair or replace damaged parts

   2) Use only for intended purposes

   3) Keep clean

4. Performance skills evaluated to the satisfaction of the instructor.

OHM'S LAW
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms and letter designations to the correct definitions and terms, state Ohm's law as well as draw it in triangular expression, list three uses of Ohm's law, and solve related problems. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with Ohm's law to the correct definitions.
2. Match letter designations used in Ohm's law to the correct terms.
3. State Ohm's law.
4. Draw Ohm's law in the magic triangle.
5. List three uses of Ohm's law.
6. List three formulas from Ohm's law.
7. Draw Ohm's law for power in the magic triangle.
8. List three uses of Ohm's law for power.
9. List three formulas from Ohm's law for power.
10. Demonstrate the ability to:
    a. Solve problems for an unknown voltage.
    b. Solve problems for an unknown amperage.
    c. Solve problems for unknown resistances and wattages.

OHM'S LAW
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and assignment sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Provide students with enough practice to meet local employment needs.

   G. Relate Ohm's law to series and parallel circuits.

   H. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete assignment sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Ohm's Law in the Magic Triangle

      2. TM 2--Three Formulas from Ohm's Law

      3. TM 3--Ohm's Law for Power in the Magic Triangle

      4. TM 4--Three Formulas from Ohm's Law for Power

D. Assignment sheets

   1. Assignment Sheet #1--Solve Problems for an Unknown Voltage

   2. Assignment Sheet #2--Solve Problems for an Unknown Amperage

   3. Assignment Sheet #3--Solve Problems for Unknown Resistances and Wattages

E. Answers to assignment sheets

F. Test

G. Answers to test

II: Reference--Miller, Franklin. *College Physics.* New York: Harcourt Brace and World, 1959.

OHM'S LAW
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Volt--Unit of measure of electromotive force or potential difference

   B. Ohm--Unit of measure for the opposition to electron flow in a circuit

   C. Amp--Unit of measure for the intensity of the electron flow in a circuit

   D. Watt--Unit of measure for the power of an electric circuit

II. Letters and terms

   A. E--Electromotive force in volts

   B. I--Intensity in amps

   C. R--Resistance in Ohms

   D. P--Power in watts

III. Ohm's law--The current in an electric circuit equals the pressure (volts) divided by the resistance

IV. Ohm's law in triangle expression (Transparency 1)

V. Uses of Ohm's law

   A. Calculating circuit resistance

   B. Calculating circuit amperage

   C. Calculating circuit voltage

VI. Formulas from Ohm's law (Transparency 2)

   A. Volts = Amps x Ohms or $E = I \times R$

   B. Amps = Volts ÷ Ohms or $I = E/R$

   C. Ohms = Volts ÷ Amps or $R = E/I$

   (NOTE: When you cover the unknown in the triangular representation of Ohm's law the remaining letters give you the problem solving equation.)

INFORMATION SHEET

VII. Ohm's law for power in the magic triangle (Transparency 3)

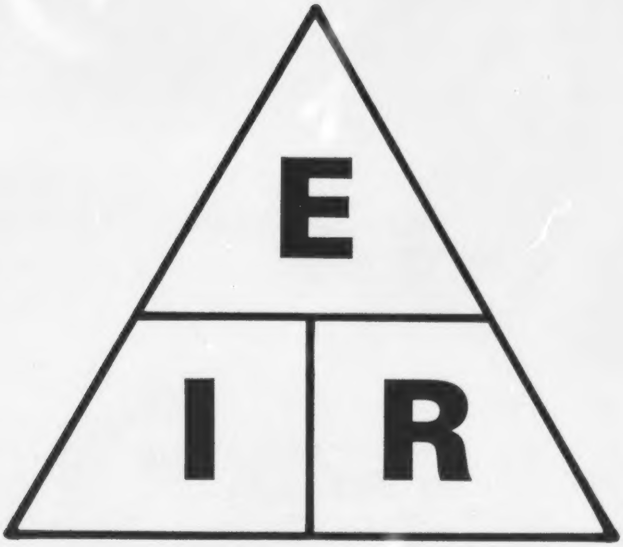
VIII. Uses of Ohm's law for power

- A. Calculating circuit wattage
- B. Calculating circuit voltage
- C. Calculating circuit amperage

IX. Formulas from Ohm's law for power (Transparency 4)

- A. Watts = Amps x Volts or P = I x E
- B. Amps = Watts ÷ Volts or I = P/E
- C. Volts = Watts ÷ Amps or E = P/I

OHM'S LAW IN THE MAGIC TRIANGLE



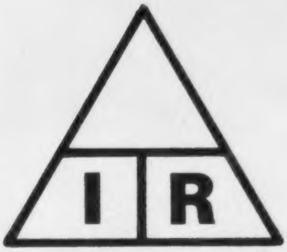
E = volts

I = amps

R = ohms

Three Formulas from Ohm's Law

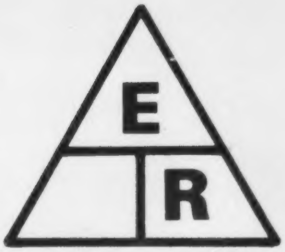
A. E =



or E = I x R

or Volts = Amps x Ohms

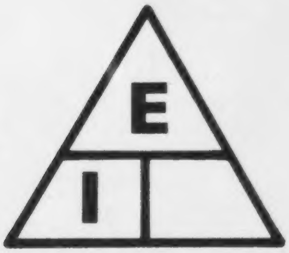
B. I =



or I = E/R

or Amps = Volts ÷ Ohms

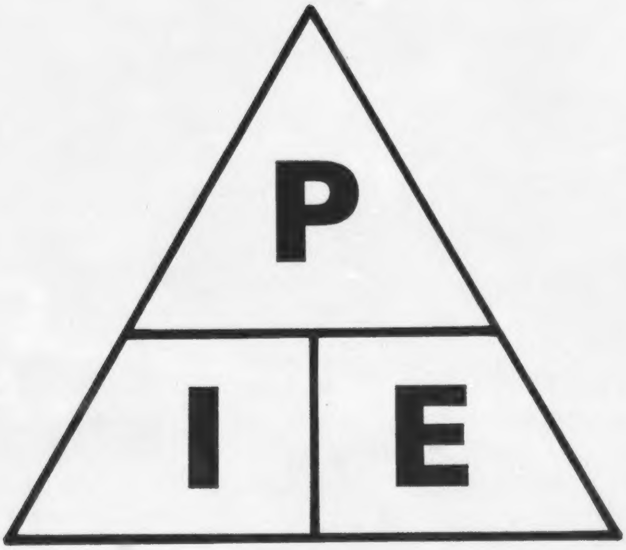
C. R =



or R = E/I

or Ohms = Volts ÷ Amps

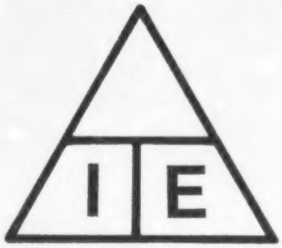
Ohm's Law for Power in the Magic Triangle



P = Watts
I = Amps
E = Volts

Three Formulas from Ohm's Law for Power

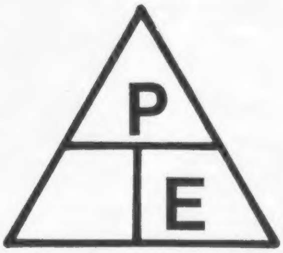
A. $P =$



or $P = I \times E$

or Watts = Amps x Volts

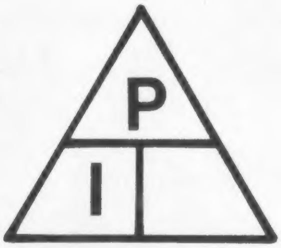
B. $I =$



or $I = P/E$

or Amps = Watts ÷ Volts

C. $E =$



or $E = P/I$

or Volts = Watts ÷ Amps

OHM'S LAW
UNIT I

ASSIGNMENT SHEET #1--SOLVE PROBLEMS FOR AN UNKNOWN VOLTAGE

Directions: Apply the appropriate formula from Ohm's law to find the voltage.

Example 1: 2 amps, 60 Ohms = _____ volts
Answer: 2 x 60 = 120

Example 2: 2 amps, 240 watts = _____ volts
Answer: 240 ÷ 2 = 120

Problems:

	Amps	Ohms		Volts	Space for figuring
1.	20	6	=	_____	
2.	4	60	=	_____	
3.	9.6	2.5	=	_____	
4.	5	2.4	=	_____	

	Amps	Watts			
5.	6	1380	=	_____	
6.	6.5	715	=	_____	
7.	2.5	1100	=	_____	
8.	5	600	=	_____	
9.	7	805	=	_____	
10.	4	500	=	_____	

OHM'S LAW
UNIT I

ASSIGNMENT SHEET #2--SOLVE PROBLEMS FOR AN UNKNOWN AMPERAGE

Directions: Apply the appropriate formula to find the amperage.

Example 1: 120 volts, 40 Ohms = ____________amps
Answer: 120 ÷ 4 = 30

Example 2: 120 watts, 120 volts = ____________amps
Answer: 120 ÷ 120 = 1

Problems:

	Volts	Ohms		Amps
1.	230	12	=	
2.	110	11	=	
3.	440	20	=	
4.	120	40	=	
5.	24	3	=	

	Watts	Volts		Amps
6.	6,000	120	=	
7.	2,640	240	=	
8.	8,800	440	=	
9.	690	115	=	
10.	2,760	230	=	

OHM'S LAW
UNIT I

ASSIGNMENT SHEET #3--SOLVE PROBLEMS FOR UNKNOWN RESISTANCES AND WATTAGES

Directions: Apply the appropriate formula to solve the problem.

Example 1: 440 volts, 10 amps = ____________Ohms
Answer: 440 ÷ 10 = 44

Example 2: 115 volts, 12 amps = ____________watts
Answer: 115 x 12 = 1,380

Problems

	Volts	Amps	Ohms
1.	240	4	
2.	24	9.6	
3.	12	5	
4.	230	5	
5.	24	8	

	Volts	Amps	Watts
6.	240	11	
7.	115	6	
8.	440	20	
9.	230	50	
10.	24	.5	

OHM'S LAW
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. 120
2. 240
3. 24
4. 12
5. 230
6. 110
7. 440
8. 120
9. 115
10. 125

Assignment Sheet #2

1. 19.2
2. 10
3. 22
4. 3
5. 8
6. 50
7. 11
8. 20
9. 6
10. 12

Assignment Sheet #3

1. 60
2. 2.5
3. 2.4
4. 46
5. 3
6. 2640
7. 690
8. 8800
9. 11,500
10. 12

OHM'S LAW
UNIT I

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Unit of measure of electromotive force or potential difference

_____b. Unit of measure for the opposition to electron flow in a circuit

_____c. Unit of measure for the intensity of the electron flow in a circuit

_____d. Unit of measure for the power of an electric circuit

1. Amp
2. Ohm
3. Volt
4. Watt

2. Match the letter designations on the right to the correct terms.

_____a. Electromotive force in volts

_____b. Intensity in amps

_____c. Resistance in Ohms

_____d. Power in watts

1. R
2. I
3. P
4. E

3. State Ohm's law.

4. Draw Ohm's law in the magic triangle.

5. List three uses of Ohm's law.

   a.

   b.

   c.

6. List three formulas from Ohm's law.

   a.

   b.

   c.

7. Draw Ohm's law for power in the magic triangle.

8. List three uses of Ohm's law for power.

   a.

   b.

   c.

9. List three formulas from Ohm's law for power.

   a.

   b.

   c.

10. Solve the following problems.

    a. 20 amps, 6 Ohms = __________ volts

    b. 5 amps, 2.4 Ohms = __________ volts

    c. 6 amps, 1380 watts = __________ volts

d. 5 amps, 600 watts = ___________volts

e. 110 volts, 11 Ohms = ___________amps

f. 24 volts, 3 Ohms = ___________amps

g. 240 volts, 2640 watts = ___________amps

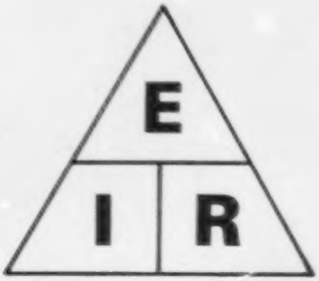
h. 115 volts, 690 watts = ___________amps

i. 240 volts, 4 amps = ___________Ohms

j. 240 volts, 11 amps = ___________Ohms

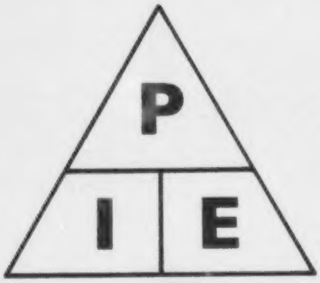
OHM'S LAW
UNIT I

ANSWERS TO TEST

1. a. 3
   b. 2
   c. 1
   d. 4
2. a. 4
   b. 2
   c. 1
   d. 3
3. The current in an electric curcuit equals the pressure (volts) divided by the resistance
4. 

5. a. Calculating circuit resistance
   b. Calculating circuit amperage
   c. Calculating circuit voltage
6. a. Volts = Amps x Ohms or E = I x R
   b. Amps = Volts ÷ Ohms or I = E/R
   c. Ohms = Volts ÷ Amps or R = E/I

7.



8. a. Calculating circuit wattage
   b. Calculating circuit voltage
   c. Calculating circuit amperage

9. a. Watts = Amps x Volts or $P = I \times E$
   b. Amps = Watts ÷ Volts or $I = P/E$
   c. Volts = Watts ÷ Amps or $E = P/I$

10. a. 120
    b. 12
    c. 230
    d. 120
    e. 10
    f. 8
    g. 11
    h. 6
    i. 60
    j. 21.8

BASIC THEORY
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms associated with basic theory to their correct definitions or symbols. The student should be able to list facts and rules about series and parallel circuits, as well as give examples of common applications. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with electrical theory to the correct definitions.
2. Match electrical schematic symbols to the correct name.
3. List two facts about an alternation cycle for 60 hertz current.
4. Differentiate between wiring diagrams and schematics.
5. Draw a schematic of a simple series circuit.
6. State four rules for series circuits.
7. List three common applications for series connections.
8. Draw a schematic of a simple parallel circuit.
9. List four rules for parallel circuits.
10. List two common applications of parallel circuits.

BASIC THEORY
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information sheet.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. If possible, show students a sign wave on an oscilloscope.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Alternation Cycle for 60 Hertz Current

    2. TM 2--Schematics and Diagrams

    3. TM 3--Simple Series Circuit

    4. TM 4--Series Circuit Rules

    5. TM 5--Parallel Circuit

    6. TM 6--Rules for Parallel Circuits

  D. Test

  E. Answers to test

BASIC THEORY
UNIT I

INFORMATION SHEET

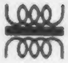
I. Terms and definitions

- A. Hertz--Unit of frequency equal to one cycle per second
- B. Alternation--The changing from positive to negative direction in alternating current (A.C.) circuits
- C. Alternating current--Electron flow that changes directions over a circuit
- D. Cycle--One complete performance of current alternation
- E. Resistance--Opposition to electron flow in a conductor or circuit
- F. Amperage--Measurement of the rate of flow of current through a conductor
- G. Voltage--The measure of the potential difference between conductors in a circuit
- H. Power--Rate of consumption of energy
- I. Conductors--Materials which permit the free flow of electrons
- J. Insulators--Materials which do not permit free flow of electrons
- K. Overcurrent device--Current limiting element in a circuit
- L. Voltage drop--Reduction in circuit potential difference due to resistance
- M. Circuit--A complete path for current to flow from the source through the load and back to the source
- N. Series circuit--An electrical circuit with all loads installed in a single path
- O. Parallel circuit--An electrical circuit with all loads installed across circuit conductors
- P. Meter--An instrument for measuring the qualities of an electrical circuit
- Q. Electricity--Invisible energy

INFORMATION SHEET

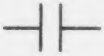
II. Schematic symbols

A. Transformer

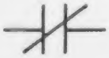


B. Contacts

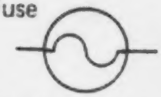
1. Normally open



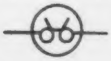
2. Normally closed



C. Fuse

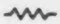


D. Fixed bimetal thermostat

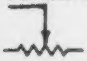


E. Resistor or load

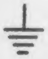
1. Fixed



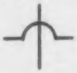
2. Variable



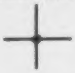
F. Ground connection



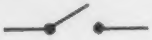
G. Wire crossover



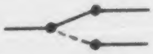
H. Wire connection



I. Single pole single throw switch

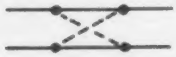


J. Three way switch

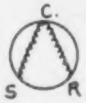


INFORMATION SHEET

K. Four way switch

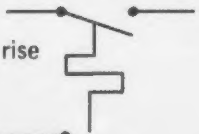


L. Single phase motor

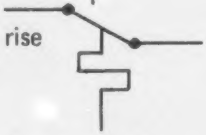


M. Thermostat

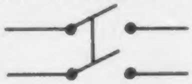
1. Closes on rise



2. Opens on rise



N. Double pole single throw switch



III. Alternation cycle for 60 hertz current (Transparency 1)

A. Current alternates from positive to negative to positive and so on

B. A cycle is completed in 1/60 second

IV. Diagrams and schematics (Transparency 2)

A. Diagrams

1. Drawing type illustrations

2. Illustrations are of actual equipment and devices

B. Schematics

1. Line type illustrations

2. Use standard schematic symbols for equipment and devices

V. Schematic of a simple series circuit (Transparency 3)

VI. Rules for series circuits (Transparency 4)

A. The sum of the voltages across the individual components equals the voltage applied to the circuit

B. The largest voltage drop occurs in the component with the highest resistance

INFORMATION SHEET

C. The sum of the resistance of the components equals the total resistance

D. Current is the same through all components of a series circuit

VII. Common applications for series connections

A. Switches

B. Overcurrent devices

C. Thermal protection devices

VIII. Schematic of a simple parallel circuit (Transparency 5)

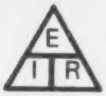
IX. Rules for parallel circuit (Transparency 6)

A. Total current equals the sum of all current of the branches

B. Voltage is the same across all branches

C. Total resistance in a parallel circuit is always less than the individual branches

Example: Resistance of individual branches of two ten ampere loads on a 120 volt circuit equals:



$$\frac{E}{I} = R = \frac{120}{10} = 12 \text{ Ohms}$$

12 Ohms per branch is more than the total resistance of:

$$\frac{E}{I} = R = \frac{120}{20} = 6 \text{ Ohms}$$

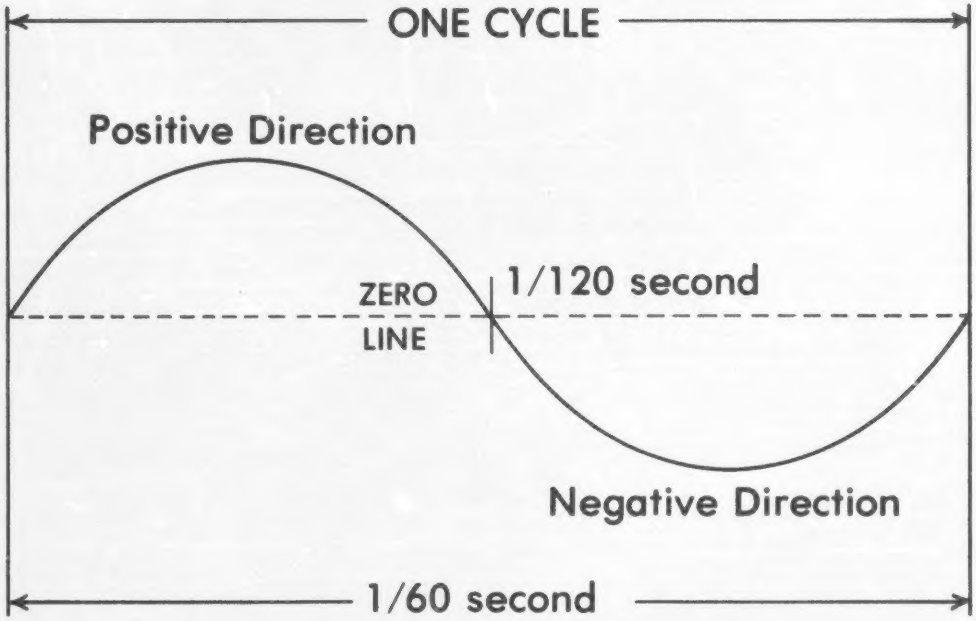
D. Total power consumed in a parallel circuit equals the sum of the power consumed in the branches

X. Common applications of parallel circuits

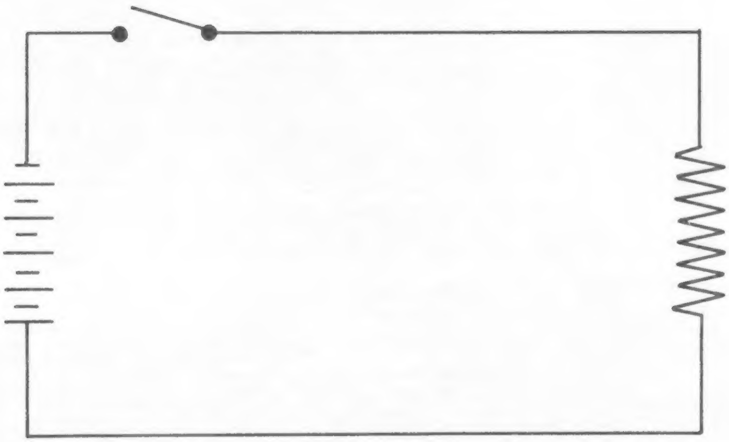
A. Supplying receptacle outlets in a residence

B. Supplying light fixtures in a residence

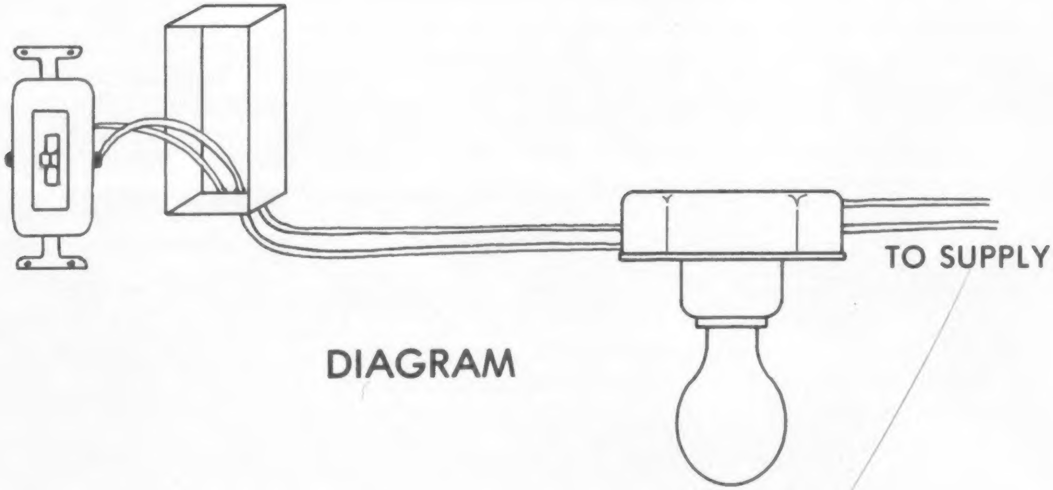
Alternation Cycle for 60 Hertz Current


ONE CYCLE
Positive Direction
ZERO
LINE
1/120 second
Negative Direction
1/60 second

Schematics and Diagrams

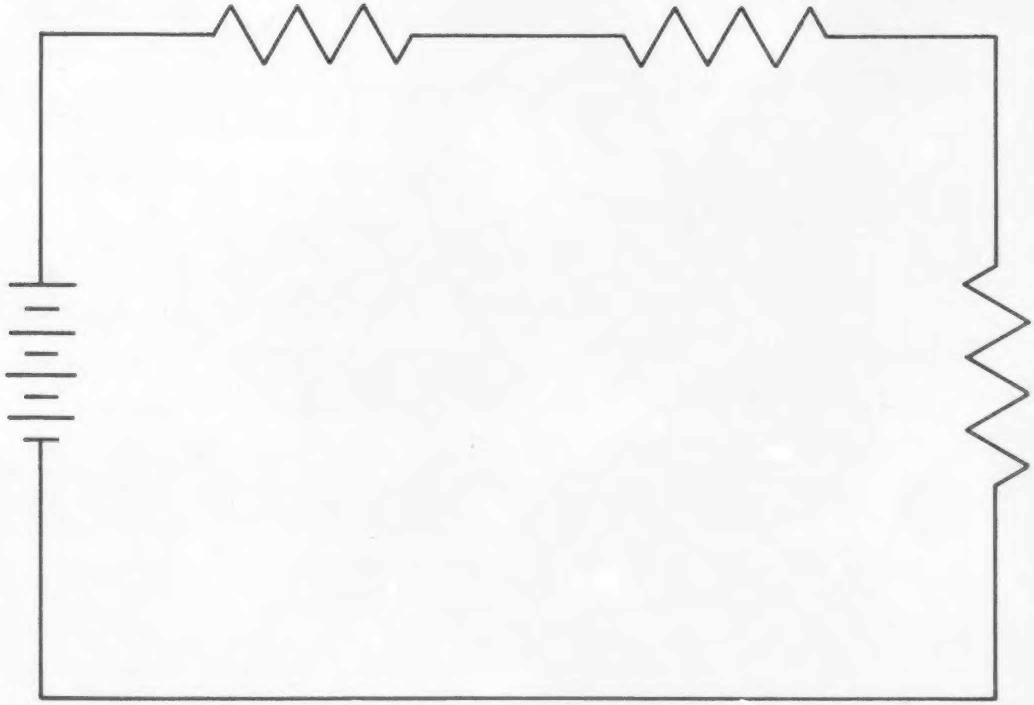


SCHEMATIC



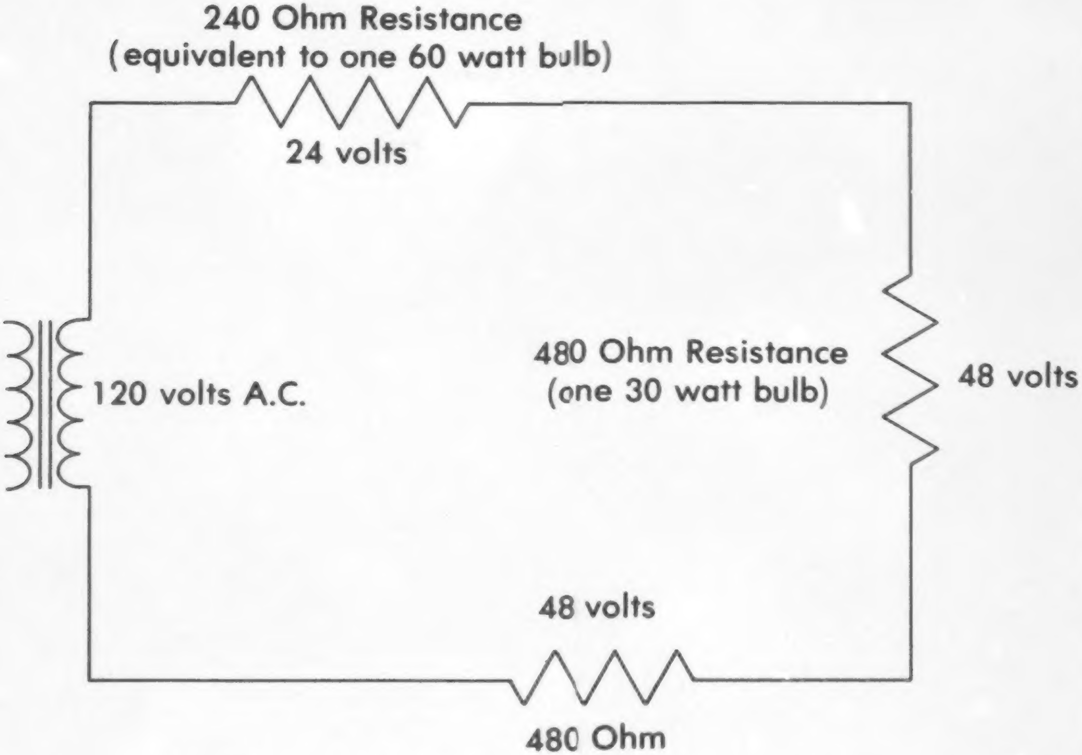
DIAGRAM

Simple Series Circuit



ONE CURRENT PATH

Series Circuit Rules


240 Ohm Resistance
(equivalent to one 60 watt bulb)
24 volts
120 volts A.C.
480 Ohm Resistance
(one 30 watt bulb)
48 volts
48 volts
480 Ohm

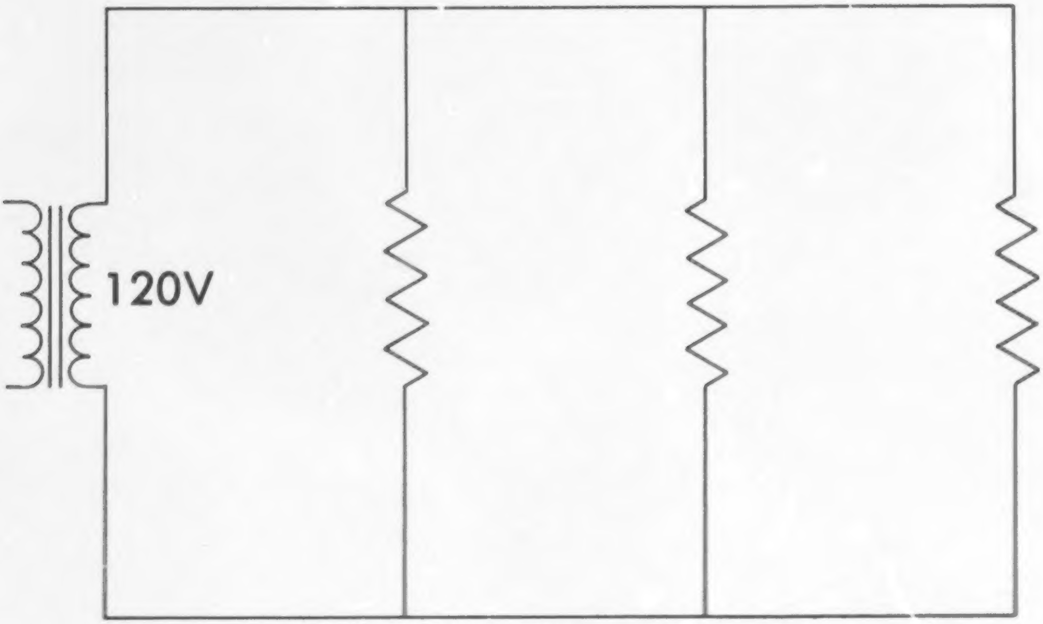
A. Total Volts = 24 + 48 + 48

B. Highest Resistance has Highest Voltage Drop

C. Total Ohms = 240 + 480 + 480

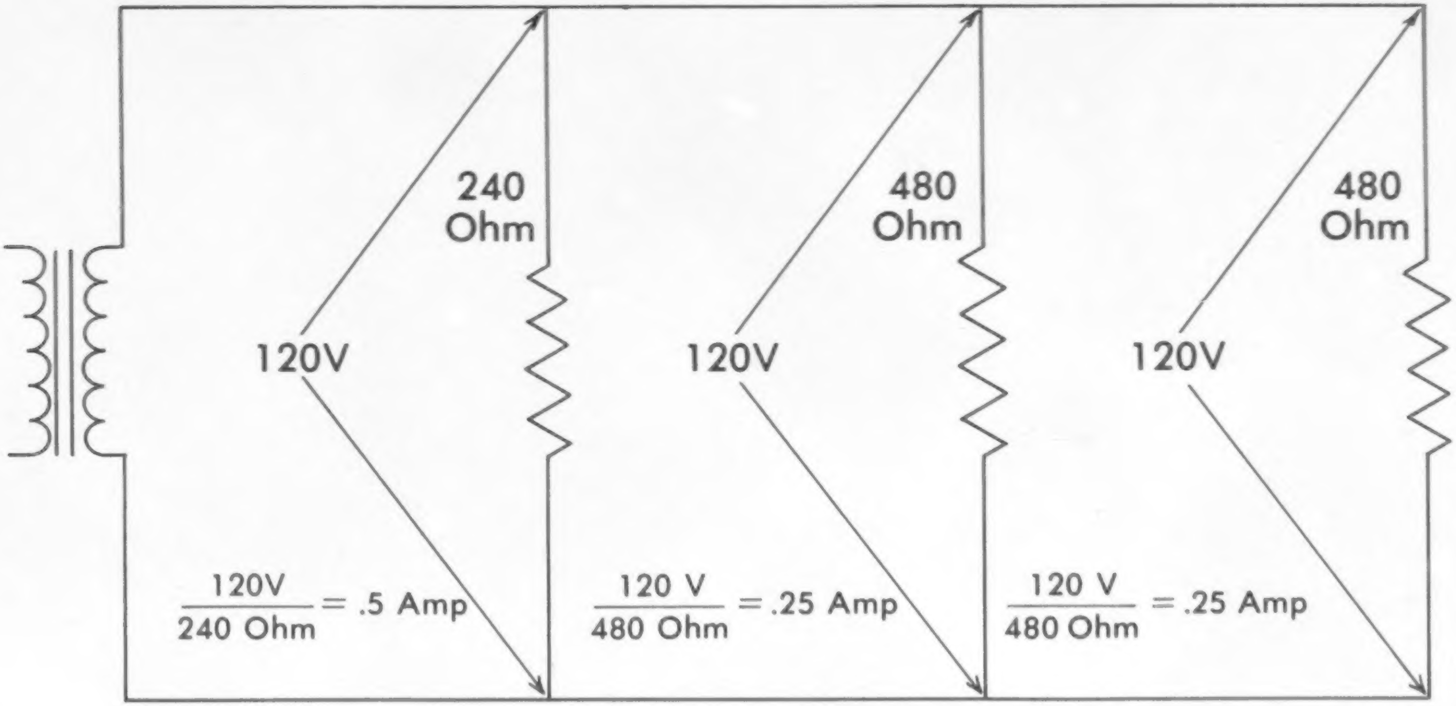
D. Total Current = 120/1200

Parallel Circuit



Circuit has Branch Paths

Rules for Parallel Circuits


240
Ohm
480
Ohm
480
Ohm
120V
120V
120V
120V / 240 Ohm = .5 Amp
120 V / 480 Ohm = .25 Amp
120 V / 480 Ohm = .25 Amp

A. Total Current = .5 + .25 + .25 = 1 amp

B. Voltage is equal across all branches

C. Total Resistance = less than branches
120V/1 Amp = 120 Ohms

D. Total Power = 60 + 30 + 30 = 120 Watts

TM 6

R - 47-C

BASIC THEORY
UNIT II

NAME ______________________

TEST

1. Match the terms on the right to the correct definitions.

______a. Unit of frequency equal to one cycle per second

______b. Electron flow that changes direction over a circuit

______c. Opposition to electron flow in a conductor or circuit

______d. The measure of the potential difference between conductors in a circuit

______e. Materials which permit the free flow of electrons

______f. Reduction in circuit potential difference due to resistance

______g. An electrical circuit with all loads installed in a single path

______h. An instrument for measuring the qualities of an electrical circuit

______i. Invisible energy

______j. An electrical circuit with all loads installed across circuit conductors

______k. A complete path for current to flow from the source through the load and back to the source

______l. Materials which do not permit free flow of electrons

______m. Current limiting element in a circuit

______n. Rate of consumption of energy

1. Alternation
2. Cycle
3. Hertz
4. Amperage
5. Conductors
6. Series circuit
7. Meter
8. Electricity
9. Power
10. Resistance
11. Alternating current
12. Voltage
13. Voltage drop
14. Insulators
15. Parallel circuit
16. Circuit
17. Overcurrent device

______o. Measurement of the rate of flow of current through a conductor

______p. One complete performance of current alternation

______q. The changing from positive to negative direction in alternating current (A.C.) circuits

2. Match the electrical schematic symbols on the right to the correct names.

______a. Contacts
    1) Normally open
    2) Normally closed

______b. Fixed bimetal thermostat

______c. Ground connection

______d. Single pole single throw switch

______e. Single phase motor

______f. Thermostat
    1) Closes on rise
    2) Opens on rise

______g. Transformer

______h. Fuse

______i. Resistor or load
    1) Fixed
    2) Variable

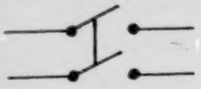
______j. Wire connection

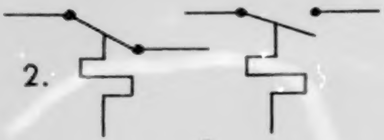
______k. Three way switch

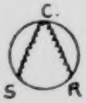
______l. Wire crossover

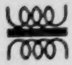
______m. Double pole single throw switch

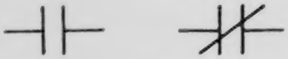
______n. Four way switch

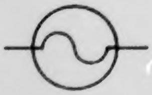
1. 

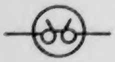
2. 

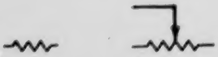
3. 

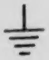
4. 

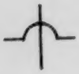
5. 

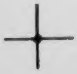
6. 

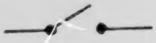
7. 

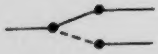
8. 

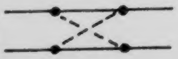
9. 

10. 

11. 

12. 

13. 

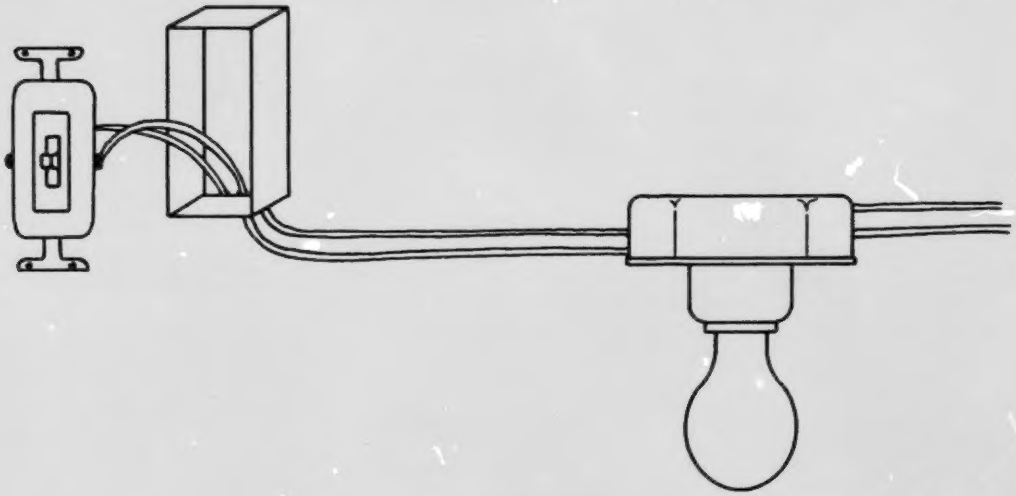
14. 

3. List two facts about an alternation cycle for 60 hertz current.

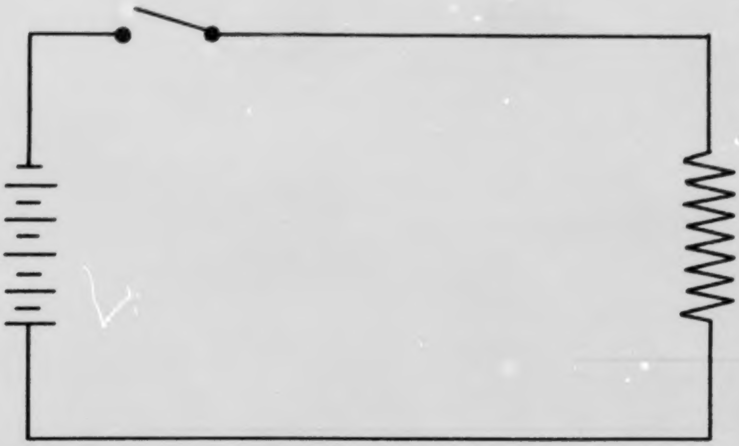
a.

b.

4. Differentiate between wiring diagrams and schematics by writing diagram or schematic in the appropriate blank.



a. ______________________________



b. ______________________________

5. Draw a schematic of a simple series circuit.

6. State four rules for series circuits.

   a.

   b.

   c.

   d.

7. List three common applications for series connections.

   a.

   b.

   c.

8. Draw a schematic of a simple parallel circuit.

9. List four rules for parallel circuits.

   a.

   b.

   c.

   d.

10. List two common applications of parallel circuits.

    a.

    b.

BASIC THEORY
UNIT II

ANSWERS TO TEST

1. a. 3
   b. 11
   c. 10
   d. 12
   e. 5
   f. 13
   g. 6
   h. 7
   i. 8
   j. 15
   k. 16
   l. 14
   m. 17
   n. 9
   o. 4
   p. 2
   q. 1

2. a. 5
   b. 7
   c. 9
   d. 12
   e. 3
   f. 2
   g. 4
   h. 6
   i. 8
   j. 11
   k. 13
   l. 10
   m. 1
   n. 14

3. a. Current alternates from positive to negative to positive and so on
   b. A cycle is completed in 1/60 second

4. a. Diagram
   b. Schematic

5. Evaluated to the satisfaction of the instructor

6. a. The sum of the voltages across the individual components equals the voltage applied to the circuit

   b. The largest voltage drop occurs in the component with the highest resistance

   c. The sum of the resistance of the components equals the total resistance

   d. Current is the same through all components of a series circuit

7. a. Switches

   b. Overcurrent devices

   c. Thermal protection devices

8. Evaluated to the satisfaction of the instructor

9. a. Total current equals the sum of all current of the branches

   b. Voltage is the same across all branches

   c. Total resistance in a parallel circuit is always less than the individual branches

   d. Total power consumed in a parallel circuit equals the sum of the power consumed in the branches

10. a. Supplying receptacle outlets in a residence

    b. Supplying light fixtures in a residence

CONDUCTORS, CABLES AND CORDS
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms associated with cables and conductors to their definitions. The student should also be able to list conductors commonly found in residential wiring as well as match them to their common applications. The student should be able to list facts about cords and cables and their conductors. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with cables and conductors to the correct definitions.
2. Match type letter designations for conductor insulations to their descriptions.
3. Discuss the size classification of conductors.
4. List the three conductors commonly found in residential wiring.
5. Match the letter type designations for insulation when given installation conditions for conductors and cables.
6. List types of cables commonly found in residential wiring.
7. Discuss cables and their uses in residential wiring.
8. List facts about cords and their conductors.
9. List facts about cables and their conductors.

CONDUCTORS, CABLES AND CORDS
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information sheet.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Show students examples of various conductors (solid and stranded), cables, and cords.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Look at examples of various conductors, cables, and cords.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Size of Conductors

    2. TM 2--Identification of Grounded Conductors in Cords

    3. TM 3--Identification of Grounding Conductors in Cords

D. Test

E. Answers to test

II. References--*National Electrical Code* 1981. Boston: National Fire Protection Association, 1980.

CONDUCTORS, CABLES AND CORDS
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Bare conductor--A conductor having no covering or electrical insulation

B. Covered conductor--A conductor encased with a material not recognized by the N.E.C. as insulation

C. Insulated conductor--A conductor encased with a material recognized by the N.E.C. as insulation

D. Type letter--Identification accepted by the trade in referring to the particular types of insulations

E. American Wire Gauge (AWG)--Classification system for wire sizes

F. Cable--Two or more conductors grouped together in an overall covering

G. Core--Two or more stranded conductors grouped together in a flexible covering

H. Mil--One thousandth of an inch

I. Circular mils--The diameter of a conductor in thousandths of inches multipled times itself

J. Sub-panel--Remote panel used for adding circuits to existing systems or localizing distribution

K. Rough-in--Initial phase of residential wiring involving such tasks as installing boxes, boring holes, and pulling wire

L. Branch circuit--The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s)

M. Grounded conductor--A circuit conductor that is intentionally connected to the earth or some conductor that serves in place of the earth

(NOTE: An insulated Grounded Conductor of No. 6 or smaller shall be identified by continuous white or natural gray outer finish along its entire length. Insulated grounded conductors larger than No. 6 will be identified by a continuous white or natural gray outer finish or at the time of installation by a distinctive white marking at its termination.)

N. Grounding conductor--Connects equipment or wiring circuit grounded conductor to a grounding electrode

(NOTE: Equipment grounding conductors will be identifiable by a continuous green color or green with one or more yellow stripes unless it is bare.)

INFORMATION SHEET

II. Type letters for conductor insulations

  A. R--Rubber

  B. T--Thermoplastic

  C. W--Moisture resistant

  D. H--Heat resistant

  E. N--Nylon jacket

  F. X--Cross linked polymer

III. Size classification of conductors (Transparency 1)

  A. American Wire Gauge (AWG)

    1. AWG is a standard size classification in the United States for copper and aluminum wires used in electrical construction

    2. AWG gets up to 0000

    (NOTE: 0000 is pronounced four naught)

  B. Thousand Circular Mils (MCM)

    1. MCM is the standard size classification for conductors larger than 0000

    2. MCM classifications go up to 2,000 MCM

IV. Conductors commonly found in residential wiring

  A. Copper

  B. Aluminum

  C. Copper-clad aluminum

V. Letter type designations and installation conditions

  A. Conductors

    1. T--Dry locations

    2. TW--Dry and wet locations

INFORMATION SHEET

3. THW--Dry and wet locations where more heat resistant qualities are needed

4. MTW--Dry and wet locations where oil may be present or where more heat resistant qualities are needed

B. Cables

1. NM (Nonmetallic-sheathed)--Dry locations; used in the majority of the residential interior wiring

(NOTE: This type cable is commonly called Romex.)

2. UF--Dry or wet locations; suitable for burial

3. SE--Dry or wet locations; used for service entrance conductors where applicable

4. USE--Dry or wet locations; suitable for direct burial

VI. Types of cables in residential wiring

A. Nonmetallic-sheathed cable (NM)

B. Service entrance cable (SE)

C. Low voltage cable

D. Underground cable (UF)

E. Underground service entrance cable (USE)

VII. Cables and their uses in residential wiring

A. Nonmetallic-sheathed cable (Romex)

1. Residential rough-in wiring in new construction

2. Extensions of existing residential wiring and new remodel

3. Feeders for sub-panels

B. Service entrance cable

1. Service entrance conductors if used with rain tight head

2. Branch circuit for ranges, cook tops, or clothes dryers

INFORMATION SHEET

C. Low voltage cable

1. Thermostat control circuits
2. Bell or chime control circuits
3. Low voltage lighting control circuits

D. Underground cable

1. Underground circuits to remote lighting such as yard lights
2. Branch circuits to out buildings such as garages

E. Underground service entrance cable--Underground service supply

VIII. Facts about cords and their conductors (Transparencies 2 and 3)

A. Cords used in a grounded system must have an identified grounded conductor

(NOTE: Article 400-22 (a) through (f) describes acceptable methods for identifying grounded conductors.)

B. Cords which have a conductor with green or green with yellow striped insulation shall use that conductor for grounding purposes only

C. Ungrounded conductors can be any color other than those designated for grounded or grounding conductors

D. Cords should be used within their amp and insulation rating or classification

IX. Facts about cables and their conductors

A. No cables other than low voltage shall have conductors smaller than #14 copper or #12 aluminum when used in residential wiring

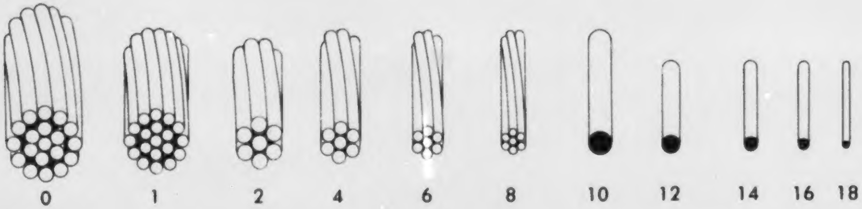
B. When used in a grounded system an identified grounded conductor (white or natural gray) must be in the cable

C. A bare or green conductor is always used as the equipment grounding conductor

D. Ungrounded conductors can be any color other than those designated for grounded or grounding conductors

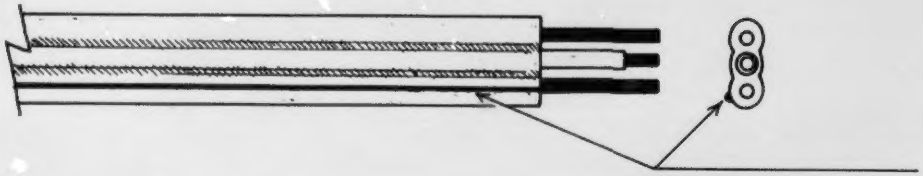
E. Cables should be used within their amp and condition rating

Size of Conductors

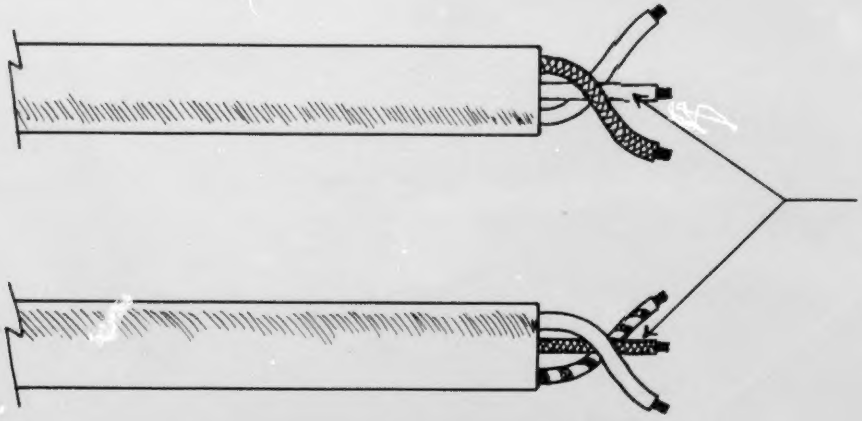

0
1
2
4
6
8
10
12
14
16
18

ACTUAL DIAMETERS OF
TYPICAL SIZES OF ELECTRIC WIRES WITHOUT THE INSULATION

Identification of Grounded Conductors in Cords

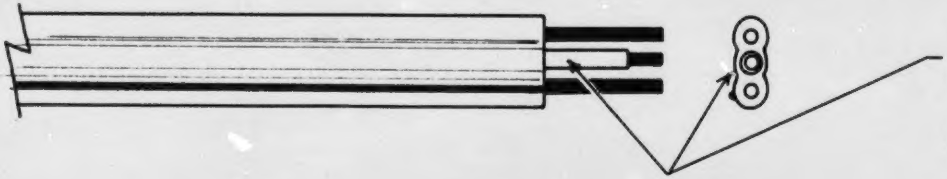


A RIDGE IS USED ON
MANY FLAT CORDS TO IDENTIFY
THE GROUNDED CONDUCTOR

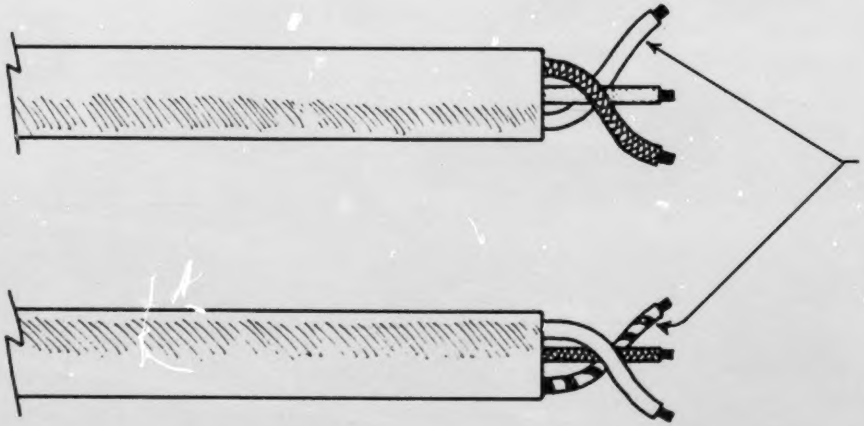


A WHITE OR NATURAL GRAY BRAID
OR MOLDED INSULATION IS OFTEN
USED ON ROUND CORDS

Identification of Grounding Conductors in Cords



A CENTRAL CONDUCTOR WITH
GREEN INSULATION IS OFTEN
INCLUDED IN FLAT CORDS AS A
GROUNDING CONDUCTOR



A GREEN OR GREEN AND YELLOW
STRIPED BRAID OR
MOLDED INSULATION IS OFTEN USED
IN ROUND CORDS TO IDENTIFY
A GROUNDING CONDUCTOR

CONDUCTORS, CABLES AND CORDS
UNIT III

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. The diameter of a conductor in thousandths of inches multiplied times itself

_____b. Initial phase of residential wiring involving such tasks as installing boxes, boring holes, and pulling wire

_____c. One thousandth of an inch

_____d. A conductor having no covering or electrical insulation

_____e. Two or more conductors grouped together in an overall covering

_____f. Remote panel used for adding circuits to existing systems or localizing distribution

_____g. Connects equipment or wiring circuit grounded conductor to a grounding electrode

_____h. A conductor encased with a material not recognized by the N.E.C. as insulation

_____i. Classification system for wire sizes

_____j. A conductor encased with a material recognized by the N.E.C. as insulation

_____k. The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s)

_____l. Two or more stranded conductors grouped together in a flexible covering

1. Covered conductor
2. Circular mils
3. Branch circuit
4. Bare conductor
5. Type letter
6. Cable
7. Sub-panel
8. Grounded conductor
9. Mil
10. American Wire Gauge (AWG)
11. Insulated conductor
12. Cord
13. Rough-in
14. Grounding conductor
15. Mil

______m. Identification accepted by the trade in referring to the particular types of insulations

______n. A circuit conductor that is intentionally connected to the earth or some conductor that serves in place of the earth

2. Match the type letter designations for conductor insulations on the right to the correct descriptions.

______a. Nylon jacket	1.	R
______b. Moisture resistant	2.	X
______c. Rubber	3.	H
______d. Heat resistant	4.	T
______e. Cross linked polymer	5.	N
______f. Thermoplastic	6.	W

3. Discuss the size classification of conductors.

4. List the three conductors commonly found in residential wiring.

a.

b.

c.

5. Match the letter type designations for insulation on the right to the installation conditions.

______a. Dry locations

______b. Dry and wet locations where oil may be present or where more heat resistant qualities are needed

______c. Dry and wet locations where more heat resistant qualities are needed

______d. Dry and wet locations

______e. Dry or wet locations; used for service entrance conductors where applicable

______f. Dry or wet locations; suitable for burial

______g. Dry locations; used in the majority of the residential interior wiring

______h. Dry or wet locations; suitable for direct burial

1. THW
2. TW
3. T
4. MTW
5. UF
6. SE
7. NM (Nonmetalic-sheathed)
8. USE

6. List four types of cables commonly found in residential wiring.

a.

b.

c.

d.

7. Discuss cables and their uses in residential wiring.

8. List three facts about cords and their conductors.

   a.

   b.

   c.

9. List three facts about cables and their conductors.

   a.

   b.

   c.

CONDUCTORS, CABLES AND CORDS
UNIT II

ANSWERS TO TEST

1. a. 2
   b. 13
   c. 9
   d. 4
   e. 6
   f. 7
   g. 14
   h. 1
   i. 10
   j. 11
   k. 3
   l. 12
   m. 5
   n. 8

2. a. 5
   b. 6
   c. 1
   d. 3
   e. 2
   f. 4

3. Discussion should include:

   a. American Wire Gauge (AWG)

      1) AWG is a standard size classification in the United States for copper and aluminum wires used in electrical construction

      2) AWG goes up to 0000

   b. Thousand Circular Mils (MCM)

      1) MCM is the standard size classification for conductors larger than 0000

      2) MCM classifications go up to 2,000 MCM

4. a. Copper
   b. Aluminum
   c. Copper-clad aluminum

5. a. 3
   b. 4
   c. 1
   d. 2
   e. 6
   f. 5
   g. 7
   h. 8

6. Any four of the following:
   a. Nonmetallic-sheathed cable (NM)
   b. Service entrance cable (SE)
   c. Low voltage cable
   d. Underground cable (UF)
   e. Underground service entrance cable (USE)

7. Discussion should include:
   a. Nonmetallic-sheathed cable (Romex)
      1) Residential rough-in wiring in new construction
      2) Extensions of existing residential wiring and new remodel
      3) Feeders for sub-panels
   b. Service entrance cable
      1) Service entrance conductors if used with rain tight head
      2) Branch circuit for ranges, cook tops, or clothes dryers
   c. Low voltage cable
      1) Thermostat control circuits
      2) Bell or chime control circuits
      3) Low voltage lighting control circuits
   d. Underground cable
      1) Underground circuits to remote lighting such as yard lights
      2) Branch circuits to out buildings such as garages
   e. Underground service entrance cable--Underground service supply

8. Any three of the following:

   a. Cords used in a grounded system must have an identified grounded conductor

   b. Cords which have a conductor with green or green with yellow striped insulation shall use that conductor for grounding purposes only

   c. Ungrounded conductors can be any color other than those designated for grounded or grounded conductors

   d. Cords should be used within their amp and insulation rating or classification

9. Any three of the following:

   a. No cables other than low voltage shall have conductors smaller than #14 copper or #12 aluminum when used in residential wiring

   b. When used in a grounded system an identified grounded conductor (white or natural gray) must be in the cable

   c. A bare or green conductor is always used as the equipment grounding conductor

   d. Ungrounded conductors can be any color other than those designated for grounded or grounding conductors

   e. Cables should be used within their amp and condition rating

THE NATIONAL ELECTRICAL CODE
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss the writing, purpose, chapter arrangement, and the use of the cross reference system of the National Electrical Code. The student should also be able to list general facts about the code book as well as demonstrate the ability to use it as a reference. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Discuss the writing of the National Electrical Code.
2. Discuss the purpose of the NEC.
3. Discuss the chapter arrangement of the NEC.
4. List general facts about the NEC.
5. List the six steps used in the cross reference system of the NEC.
6. Answer questions related to residential wiring practices using the National Electrical Code as a reference.
7. Locate allowable ampacities for various conductors using the National Electrical Code as a reference.
8. Interpret conduit fill tables using the National Electrical Code as a reference.

THE NATIONAL ELECTRICAL CODE
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and assignment sheets.

   C. Discuss unit and specific objectives.

   D. Discuss information and assignment sheets.

   E. Provide students with a copy of the National Electrical Code.

   F. Stress importance of the National Electrical Code.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete assignment sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Assignment sheets

      1. Assignment Sheet #1--Answer Questions Related to Residential Wiring Practice Using the National Electrical Code as a Reference

      2. Assignment Sheet #2--Locate Allowable Ampacities for Various Conductors Using the National Electrical Code as a Reference

      3. Assignment Sheet #3--Interpret Conduit Fill Tables Using the National Electrical Code as a Reference

   D. Answers to assignment sheets

E. Test

F. Answers to test

II. Reference--*National Electrical Code* 1981. Boston: National Fire Protection Association, 1980.

THE NATIONAL ELECTRICAL CODE
UNIT I

INFORMATION SHEET

I. Writing of the National Electrical Code

   A. Usually revised and reprinted every three years

   B. Code-making panels revise and rewrite articles

   C. Individauls, groups, or committees can propose the revision of an article

   D. National Fire Protection Association sets rules and regulations for publication

   (NOTE: Through the rest of this unit and in subsequent units the National Electrical Code will be represented by the abbreviation NEC.)

II. Purpose of the NEC

   A. Practical safeguarding of persons and property from hazards arising from the use of electricity

   B. Provides minimum standards for safe installations

   C. The NEC is not intended as a design specification nor an instructional manual for untrained persons

III. Chapter arrangement of the NEC

   A. Chapters 1, 2, 3, and 4 apply generally and can be modified in later chapters

   B. Chapters 5, 6, and 7 apply to special occupancies, equipment, or conditions

   C. Chapter 8 applies to communications systems

   D. Chapter 9 gives tables and examples

IV. General facts about NEC

   A. NEC articles can be changed locally by city or state electrical codes

   (NOTE: This is usually done where conditions make it unsafe to follow NEC practices, An example would be the alteringof cable burying practices where soil conditions are acidic and could damage certain types of insulation.)

   B. The NEC does not have power of law

   (NOTE: Enforcement of the code is done through the agency responsible for electrical installation as they adopt it.)

INFORMATION SHEET

C. Mandatory rules are characterised by the word "shall"

D. Explanatory material appears in fine print

V. Steps used in the cross reference system of the NEC

A. Locate topics in the index

(NOTE: The index is in the back of the NEC just before the appendix and is alphabetically arranged.)

B. Note article and section of topic

C. Find article listed in numerical order in the table of contents in the front of the NEC

D. Locate appropriate article and read across to find page number

(NOTE: Page numbers do not appear with the number "70" in them in the table of contents but they will in the book proper.)

E. Turn to page listed as chapter beginning

F. Find section number needed in article

THE NATIONAL ELECTRICAL CODE
UNIT I

ASSIGNMENT SHEET #1--ANSWER QUESTIONS RELATED TO RESIDENTIAL WIRING PRACTICES USING THE NATIONAL ELECTRICAL CODE AS A REFERENCE

Directions: Give article number and answer to questions.

(NOTE: The problem solving steps listed below are taken from number V on the information sheet.)

Example: Are ground-fault circuit interupters required on 125 volt single phase 20 amp temporary construction receptacles

Step 1: Refer to index: "Ground-Fault Interupters" is located and "Construction Sites" is listed.

Step 2: Note listing of article

Step 3: Turn to table of contents and locate article number.

Step 4: Read across to page number.

Step 5: Find the page number for the article on branch circuits, turn to it.

Step 6: Find section number by turning pages in article

Answer: From the article on branch circuits, 20 amp receptacles on temporary poles do require ground-fault circuit interupters.

Problems

1. Do boxes made of metal need to be corrosion resistant?

   Answer:

2. What is the definition of "ampacity"?

   Answer:

3. Can a branch circuit used for lighting purposes and rated at 20 amps have a 12 amp dishwasher or other fixed appliance connected to it?

   Answer:

THE NATIONAL ELECTRICAL CODE
UNIT I

ASSIGNMENT SHEET #2--LOCATE ALLOWABLE AMPACITIES FOR VARIOUS CONDUCTORS USING THE NATIONAL ELECTRICAL CODE AS A REFERENCE

Directions: List the various ampacities for the conductors as listed.

Example: List the ampacities for the following conductors when used in a 3 conductor cable.

1. #12 TW copper _____
2. #6 TW copper _____

Answers:

1. 20 amps
2. 55 amps

Problems:

What is the allowable ampacity for the following single insulate copper conductors used in free air?

1. 14 TW _____

2. 1 TW _____

3. 1 THWN _____

4. 10 THW _____

What is the allowable ampacity for the following aluminum conductors when used in a 3 wire cable?

5. 10 TW _____

6. 12 TW _____

7. 1/0 TW _____

8. 6 TW _____

THE NATIONAL ELECTRICAL CODE
UNIT I

ASSIGNMENT SHEET #3--INTERPRET CONDUIT FILL TABLES USING THE NATIONAL ELECTRICAL CODE AS A REFERENCE

Directions: List the maximum number of conductors allowed in the following conduits. Use same steps as listed on Assignment Sheet #1 to locate answers.

1/2" conduit

1. 14 TW _____
2. 10 TW _____
3. 6 TW _____

3/4" conduit

4. 10 THWN _____
5. 4 THWN _____

1" conduit

6. 6 TW _____
7. 2 TW _____
8. 6 THWN _____

2" conduit

9. 4/0 THWN _____
10. 4/0 TW _____

THE NATIONAL ELECTRICAL CODE
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. Metal boxes shall be corrosion-resistant
2. Ampacity: Current-carrying capacity of conductors expressed in amperes
3. No, fixed appliances cannot exceed 50 percent of a branch circuit rated at 15 or 20 amperes and used for lighting purposes

Assignment Sheet #2

1. 20
2. 165
3. 195
4. 40
5. 25
6. 15
7. 100
8. 40

Assignment Sheet #3

1. 9
2. 5
3. 1
4. 11
5. 2
6. 4
7. 2
8. 6
9. 4
10. 3

THE NATIONAL ELECTRICAL CODE
UNIT I

NAME ____________________

TEST

1. Discuss the writing of the National Electrical Code.

2. Discuss the purpose of the NEC.

3. Discuss the chapter arrangement of the NEC.

4. List three general facts about the NEC.

   a.

   b.

   c.

5. List the six steps used in the cross reference system of the NEC.

   a.

   b.

   c.

   d.

   e.

   f.

6. Answer questions related to residential wiring practices using the National Electrical Code as a reference.

7. Locate allowable ampacities for various conductors using the National Electrical Code as a reference.

8. Interpret conduit fill tables using the National Electrical Code as a reference.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

THE NATIONAL ELECTRICAL CODE
UNIT I

ANSWERS TO TEST

1. Discussion should include
   - a. Usually revised and reprinted every three years
   - b. Code-making panels revise and rewrite articles
   - c. Individuals, groups, or committees can propose revision of an article
   - d. National Fire Protection Association sets rules and regulations for publication
2. Discussion should include
   - a. Practical safeguarding of persons and property from hazards arising from the use of [illegible]city
   - b. Provides [illegible]nimum standards for safe installations
   - c. The NEC is not intended as a design specification nor an instructional manual for untrained persons
3. Discussion should include:
   - a. Chapters 1, 2, 3, and 4 apply generally and can be modified in later chapters
   - b. Chapters 5, 6, and 7 apply to special occupancies, equipment, or conditions
   - c. Chapter 8 applies to communications systems
   - d. Chapter 9 gives tables and examples
4. Any three of the following:
   - a. NEC articles can be changed locally by city or state electrical codes
   - b. The NEC does not have power of law
   - c. Mandatory rules are characterized by the word "shall"
   - d. Explanatory materials appears in fine print
5. Discussion should include:
   - a. Locate topics in the index
   - b. Note article and section of topic

   c. Find article listed in numerical order in the table of contents in the front of the NEC

   d. Locate appropriate article and read across to find page number

   e. Turn to page listed as chapter beginning

   f. Find section number needed in article

6. Evaluated to the satisfaction of the instructor

7. Evaluated to the satisfaction of the instructor

8. Evaluated to the satisfaction of the instructor

BLUEPRINTS AND SPECIFICATIONS
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms, symbols, and names associated with blueprints and specifications to their definitions, descriptions, or pictures. The student should also be able to list information commonly found on specifications and the steps used in reading a rule. The student should also be able to read a rule and measure objects using a rule. This information will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with blueprints and specifications to the correct definitions.
2. Identify blueprint symbols used in residential drawings.
3. Identify electrical blueprints symbols.
4. Match the names of types of lines to their pictures and descriptions.
5. List kinds of information commonly found in blueprint specifications.
6. List steps in reading a rule.
7. Read a rule.
8. Measure objects using a rule.

BLUEPRINTS AND SPECIFICATIONS
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and assignment sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Show students examples of blueprints.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete assignment sheets.

   D. Look at examples of blueprints.

   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Electrical Floor Plan

      2. TM 2--Alphabet of Lines

      3. TM 3--Alphabet of Lines (Continued)

      4. TM 4--Alphabet of Lines (Continued)

      5. TM 5--Graduations on a Rule

6. TM 6--Reading the Eighths Rule

7. TM 7--Reading the Sixteenths Rule

D. Assignment sheets

1. Assignment Sheet #1--Read a Rule

2. Assignment Sheet #2--Measure Objects Using a Rule

E. Answers to assignment sheets

F. Test

G. Answers to test

II. References:

A. Dalzell, James R. *Blueprint Reading for Home Builders.* New York: McGraw-Hill, 1955.

B. French, Thomas E., and Vierch, Charles J. *Engineering Drawing.* New York: McGraw-Hill, 1966.

C. Hepler, Donald E., and Wallach, Paul I. *Architectural Drafting and Design.* New York: McGraw-Hill, 1971.

D. Hornung, William J. *Architectural Drafting.* Englewood, New Jersey: Prentice Hall, 1949.

E. McDonnell, Leo P. *Blueprint Reading and Sketching for Carpentry Trades (Residential).* New York: Delmar, 1957.

F. Wagner, Willis H. *Modern Carpentry.* Homewood, Illinois: Goodheart-Willcox, 1969.

G. Penner, Wayman R. *Residential Carpentry.* Stillwater, Oklahoma: Curriculum and Instructional Materials Center, 1973.

BLUEPRINTS AND SPECIFICATIONS
UNIT II

INFORMATION SHEET

I. Terms and definitions

   A. Blueprint lines--Set of conventional symbols used to depict an object as to size or shape

   B. Dimensions--The arrangement of lines and symbols to indicate the actual size for constructing the object that is represented

   C. Specifications--A detailed set of written instructions which explain the drawing and become a part of the contract

   D. Symbol--An arbitrary sign that has been standardized and is used to represent an object, quantity, or method

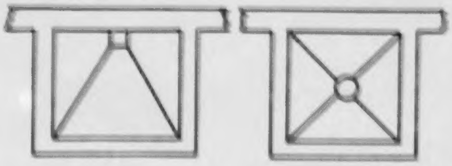
   E. Floor plan--A detailed drawing of a building as if it were cut through horizontally to show rooms, partitions, windows, doors, stairs, and electrical outlets

   F. Blueprint--A copy of the original detailed drawing

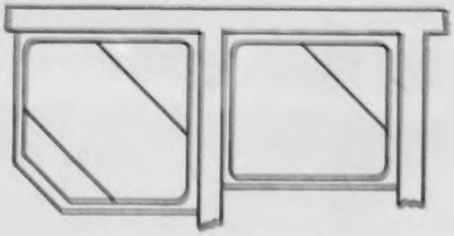
   G. Rule--An instrument that is graduated in whole units and fractions of units and used in measuring

II. Blueprint symbols

   A. Plumbing

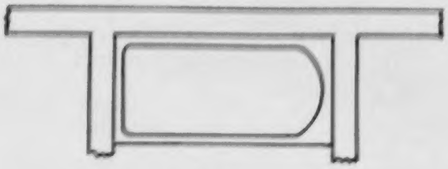


1. Showers

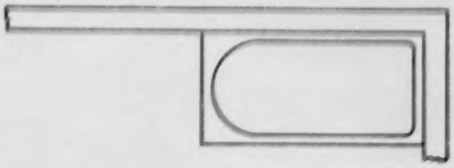


2. Square corner bathtub

3. Built-in square bathtub

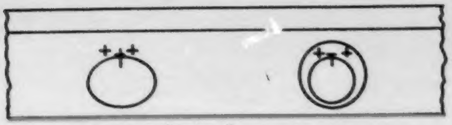


4. Built-in bathtub

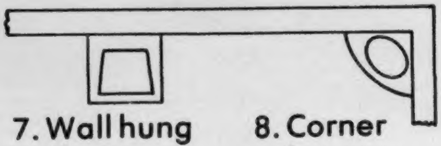


5. Corner bathtub

INFORMATION SHEET

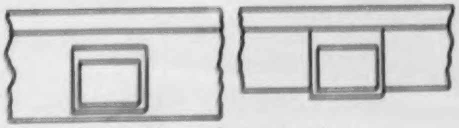


6. Built-in lavatories

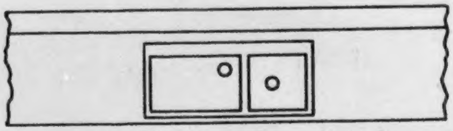


7. Wall hung lavatory

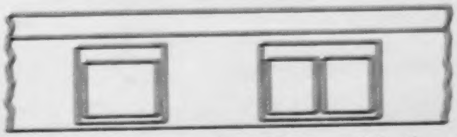
8. Corner lavatory



9. Built-in lavatories

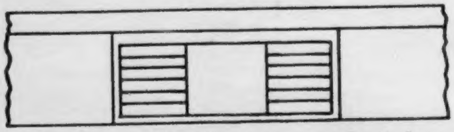


10. Shallow bowl sink

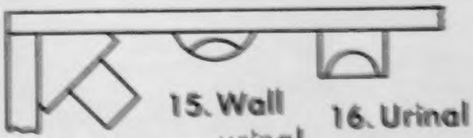


11. Single bowl sink

12. Double bowl sink



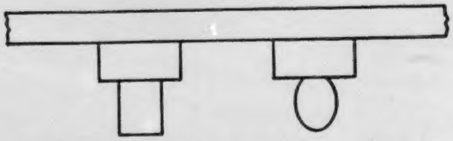
13. Double drainboard sink with cabinet



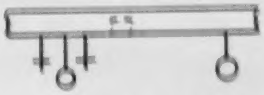
14. Corner water closet

15. Wall urinal

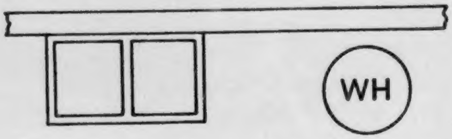
16. Urinal



17. Toilet stools or water closets



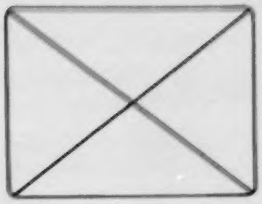
18. Shower heads



19. Laundry tubs

20. Water heater

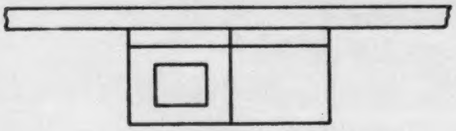
(designate capacity and fuel)



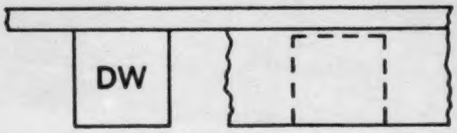
21. Furnace

INFORMATION SHEET

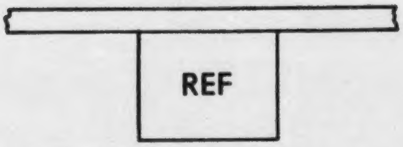
B. Appliances



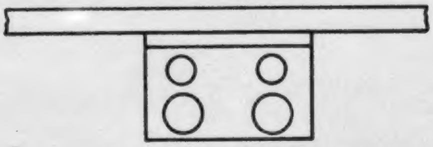
1. Washer and dryer



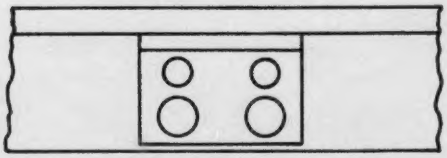
2. Freestanding and built-in dishwashers



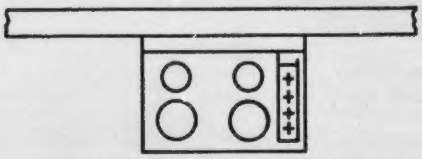
3. Refrigerator or freezer



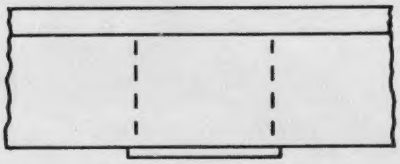
4. Freestanding range



5. Drop-in range



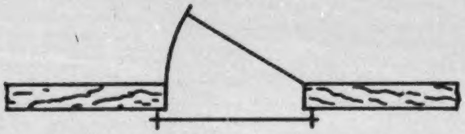
6. Surface cook top



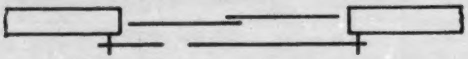
7. Built-in oven

INFORMATION SHEET

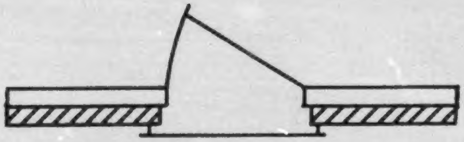
C. Structural symbols



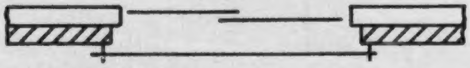
1. Plan view of exterior door in wood frame wall



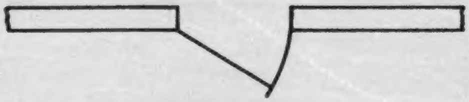
2. Plan view of exterior sliding door in wood frame wall



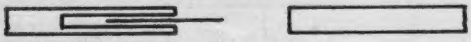
3. Plan view of exterior door in masonry veneer wall



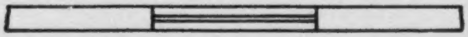
4. Plan view of exterior sliding door in masonry veneer wall



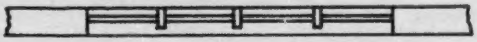
5. Plan view of interior hinged door



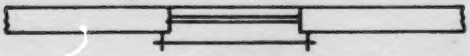
6. Plan view of interior pocket door



7. Single window in frame wall



8. Multiple windows in frame wall



9. Plan view of double hung window in frame wall

INFORMATION SHEET

III. Electrical blueprint symbols (Transparency 1)

A. Single pole switch-- S

B. Three way switch-- S_3

C. Four way switch-- S_4

D. Automatic door switch-- S_D

E. Switch with pilot light-- Sp

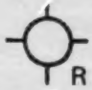
F. Weatherproof switch-- Swp

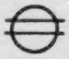
G. Double pole switch-- S_2

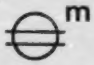
H. Switch for low voltage system - $\underline{S}$

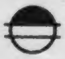
I. Low voltage wire-- ———— — — ——— — — ————

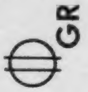
J. Low voltage master switch-- Ms

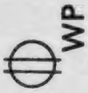
K. Relay equipped lighting outlet-- 

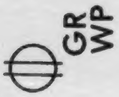
L. Duplex receptacle outlet-- 

M. Receptacle outlet other than duplex-- 

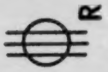
N. Split wired receptacle outlet-- 

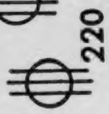
O. Grounding type duplex receptacle outlet-- 

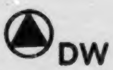
P. Weatherproof duplex outlet-- 

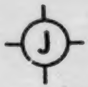
Q. Weatherproof grounding type duplex receptacle outlet-- 

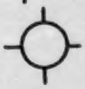
INFORMATION SHEET

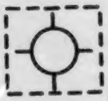
R. Range outlet-- 

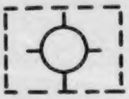
S. 220 volt outlet-- 

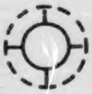
T. Special--Must be explained in the key to the symbols-- 

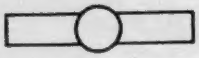
U. Junction box-- 

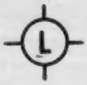
V. Lighting outlet-- 

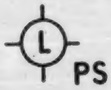
W. Square recessed light (size varies)-- 

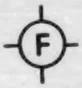
X. Rectangular recessed light (size varies)-- 

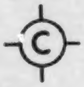
Y. Round recessed light (size varies)-- 

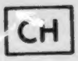
Z. Fluorescent light-- 

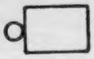
AA. Lampholder-- 

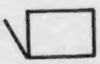
BB. Lampholder with pull switch-- 

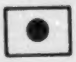
CC. Fan outlet-- 

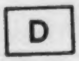
DD. Clock outlet-- 

EE. Chime-- 

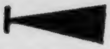
FF. Bell-- 

GG. Buzzer-- 

HH. Push button-- 

II. Electric door opener-- 

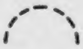
INFORMATION SHEET

JJ. Telephone-- 

KK. T.V. outlet-- TV

LL. Master power service panel-- ▨

MM. Lighting distribution panel-- ▮

NN. Switch leg indicator-- 

OO. Baseboard heat-- ━━━━━━━━

IV. Alphabet of lines (Transparencies 2, 3, and 4)

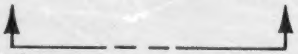
A. Object lines--(————————)--Show the main outline of the building including exterior walls, interior partitions, porches, patios, driveways, and interior walls; these lines should be the outstanding lines on a drawing

B. Dimension lines--(◄————————————►)--Thin unbroken lines which building dimensions are placed upon

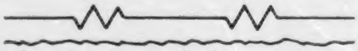
C. Extension lines--(————————————)--Extend, but do not touch, the object lines and permit dimension lines to be drawn between them

D. Hidden lines--(— — — — — — — — — — — — —)--Short dashes used to show lines that are not visible from that view

E. Center lines--(——— — ——————— — ———)--A series of short and long dashes used to designate the center of doors, windows, and circles and to provide a reference point for dimensioning

F. Cutting-plane lines--()--Heavy lines consisting of a series of one long and two short dashes with arrows at each end pointing away from the area that is cut away for the purpose of sectioning

G. Section lines--(//////////////////)--A series of lines of various shapes or symbols used to depict an area that is a cross section of the whole object and also depicts the type of material to be used in construction

H. Break lines--()--Used when an area cannot or should not be drawn entirely

I. Leaders--( )--Used to connect a note or dimension to a part of the building

INFORMATION SHEET

V. Information commonly found in blueprint specifications

A. Sizes

B. Types and quality of building materials

C. Methods of construction

D. Material lists

(NOTE: This can include electrical lists as supplied by the electrical contractor in his bids to the general contractor.)

E. Owner's name and address

F. Contractor's name and address

G. Location of new structure

H. Completion date

I. Contractor's bid

J. Guarantees

K. Blueprint number

Example: This is an example of a detailed specification statement for the electrical contractor on a small residence

Electrical

This contractor shall install a complete electrical system as per these plans and specifications.

All receptacles as shown shall be of the duplex grounding type. Install telephone outlets and television jacks as shown. Connect dishwasher, surface unit burners, built-in oven, clothes dryer, clothes washer, exhaust fan, furnace, and others as shown.

Furnish and install 16 circuit breaker box. All equipment described above, and refrigerator, deep freeze in the basement, air conditioning unit, and compactor, are to be on separate circuits.

Each room shall have receptacles and lights on at least two separate circuits.

All switches are to be of the mercury, silent type.

Provide 200 amp., 115-230 volt entrance service.

Make alternate bid for underground neoprene entrance service.

Allow $300.00 for electrical fixtures, excluding installation.

All fixtures to be selected by the owner.

INFORMATION SHEET

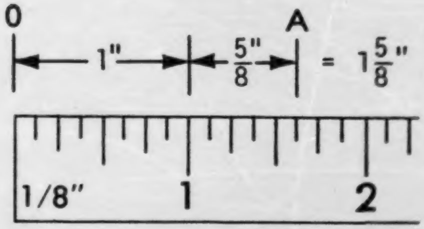
VI. Steps in reading a rule (Transparencies 5, 6, and 7)

A. Determine the graduations per inch on rule

(NOTE: The graduations vary. You can count all the marks in an inch, or a half inch and multiply by two, or one quarter inch and multiply by four to find this information.)

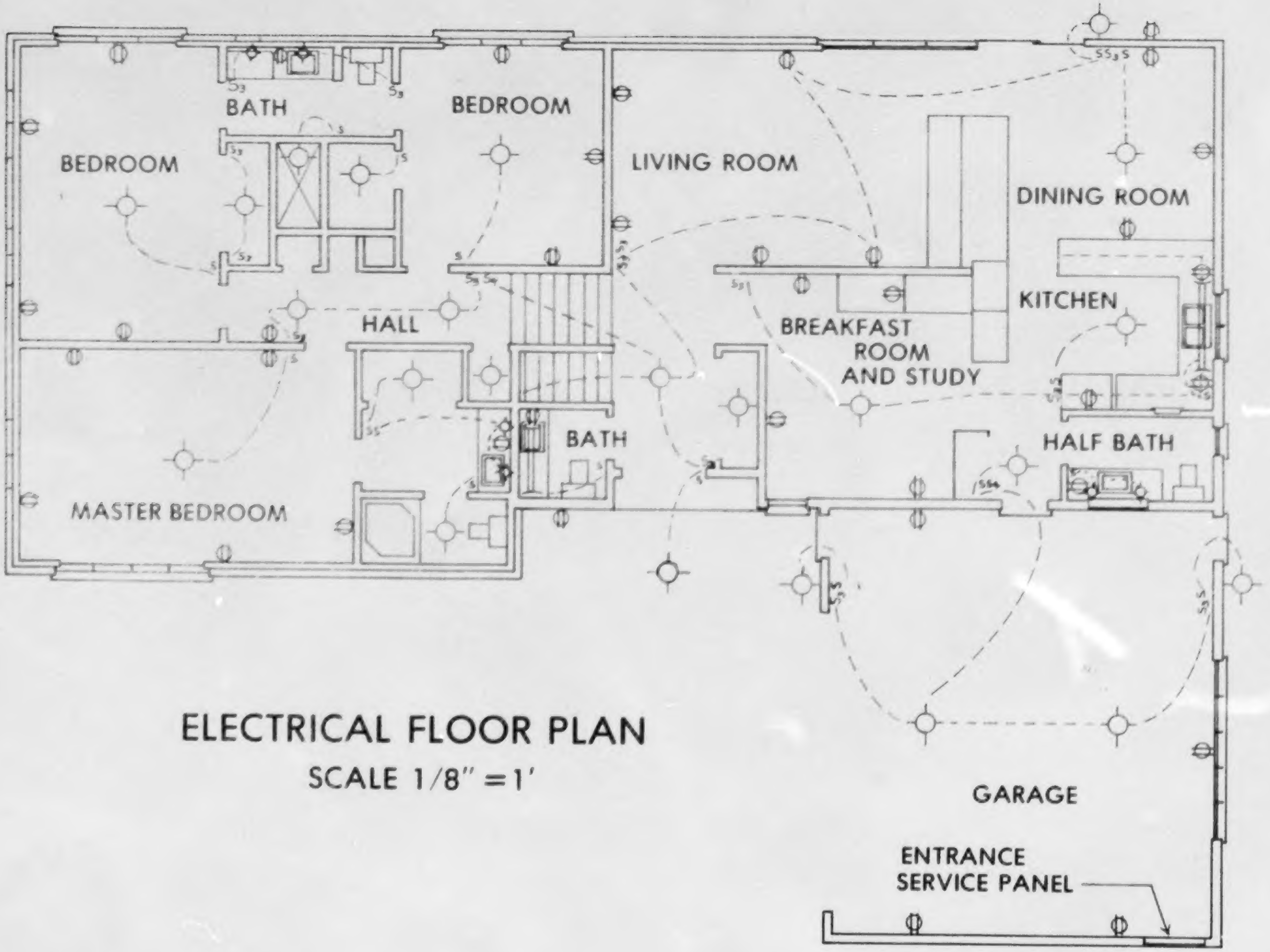
B. Determine inches and fractions of inches

Example:



(NOTE: In the example the rule has eight graduations or marks per inch. From 0 to point "A" is 1 5/8".)

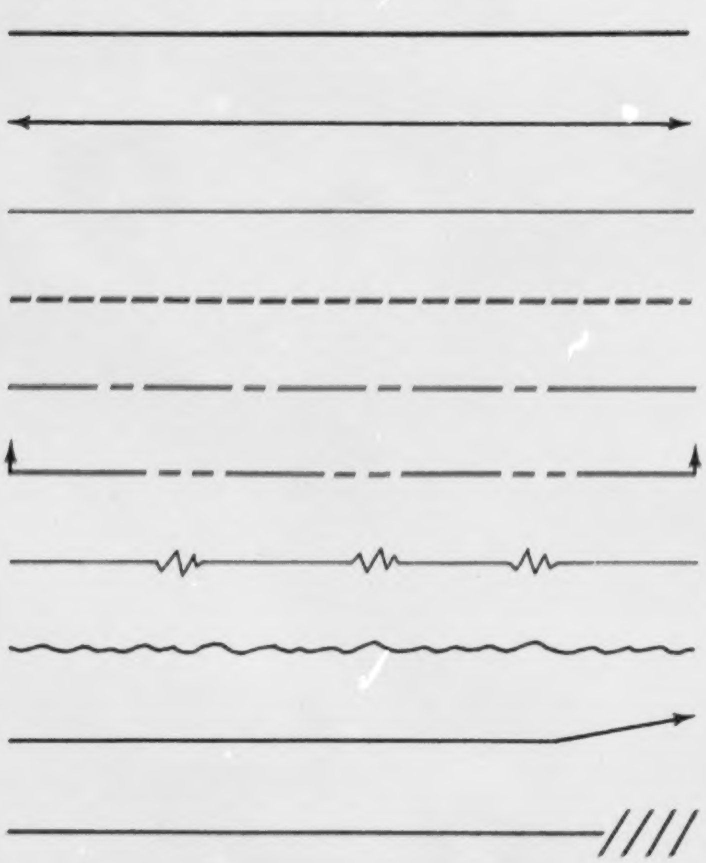
C. Determine the feet and add inches and fractions of inches


BATH
BEDROOM
BEDROOM
LIVING ROOM
DINING ROOM
KITCHEN
HALL
BREAKFAST ROOM AND STUDY
BATH
HALF BATH
MASTER BEDROOM
GARAGE
ENTRANCE SERVICE PANEL

ELECTRICAL FLOOR PLAN

SCALE 1/8" = 1'

Alphabet of Lines



Object Line

Dimension Line

Extension Line

Hidden Line

Center Line

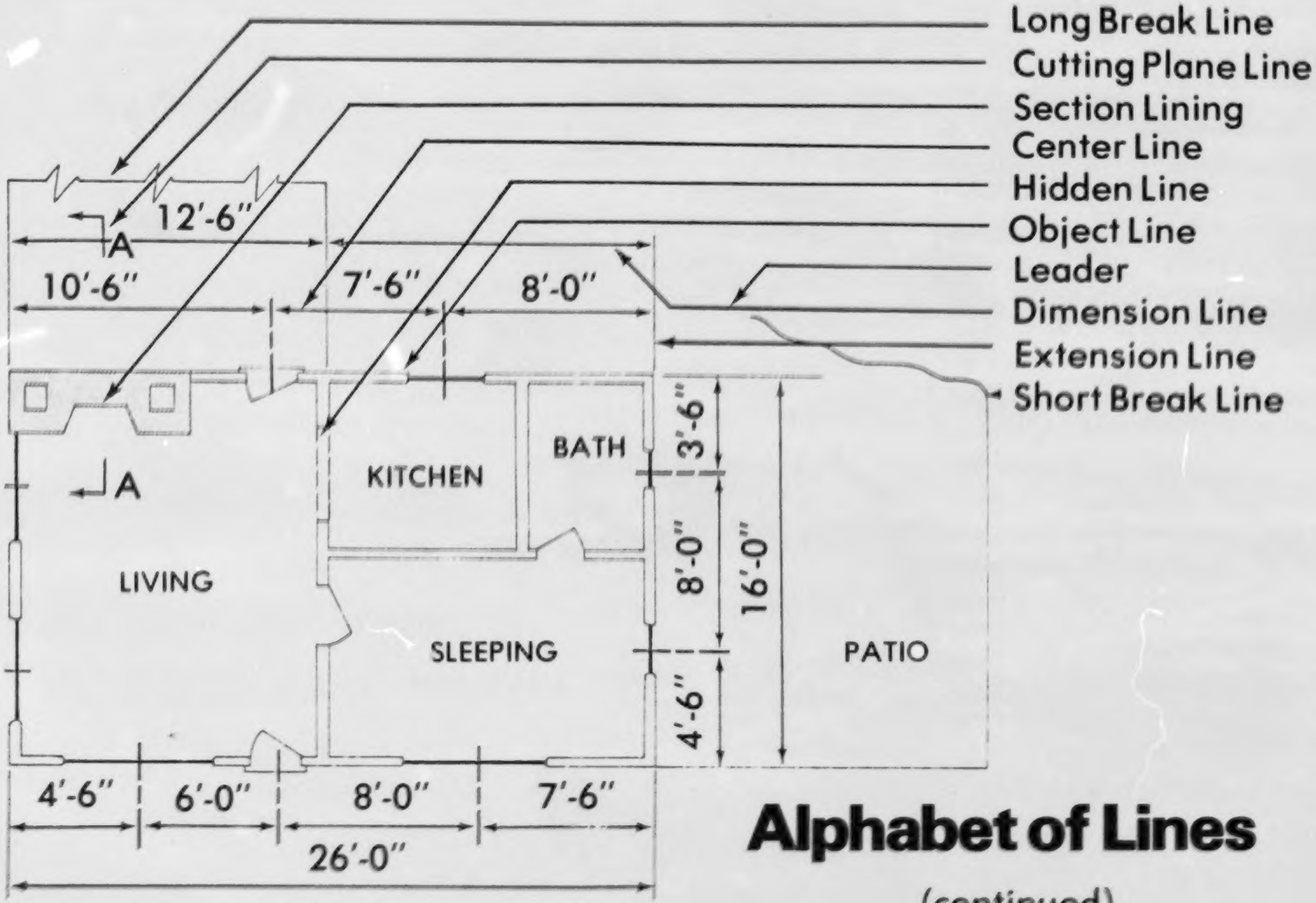
Cutting Plane

Break Line-Long

Break Line -Short

Leader

Section Lining

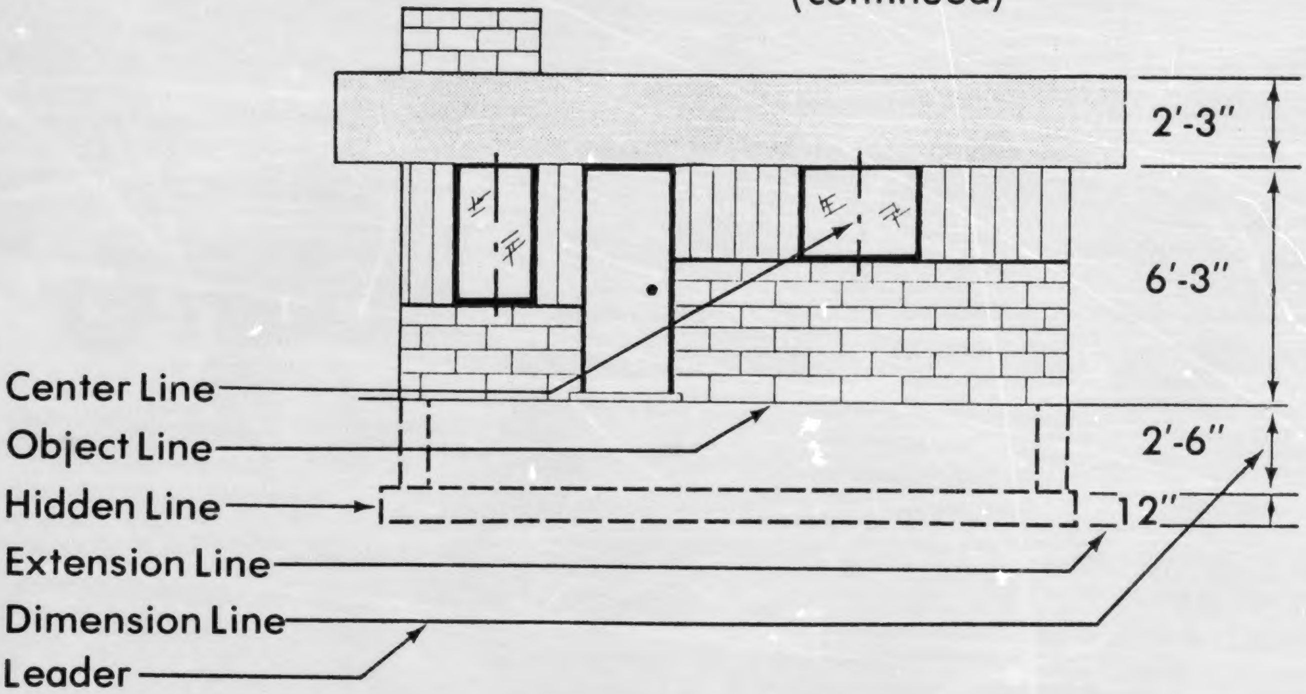

Long Break Line
Cutting Plane Line
Section Lining
Center Line
Hidden Line
Object Line
Leader
Dimension Line
Extension Line
Short Break Line
12'-6"
A
10'-6"
7'-6"
8'-0"
A
KITCHEN
BATH
LIVING
SLEEPING
PATIO
3'-6"
8'-0"
16'-0"
4'-6"
4'-6"
6'-0"
8'-0"
7'-6"
26'-0"

Alphabet of Lines

(continued)

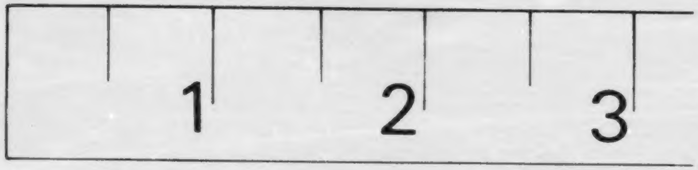
Alphabet of Lines

(continued)

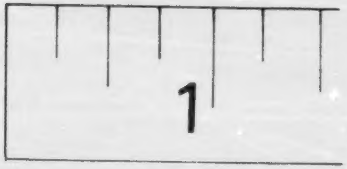

2′-3″
6′-3″
2′-6″
12″
Center Line
Object Line
Hidden Line
Extension Line
Dimension Line
Leader

Graduations on a Rule

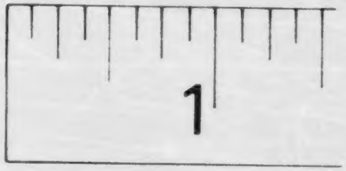
Halves



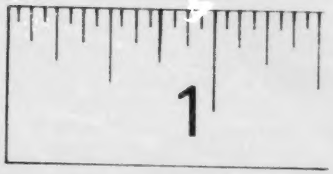
Quarters



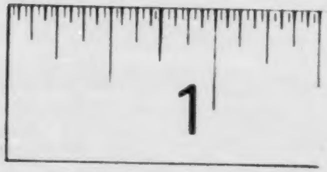
Eighths

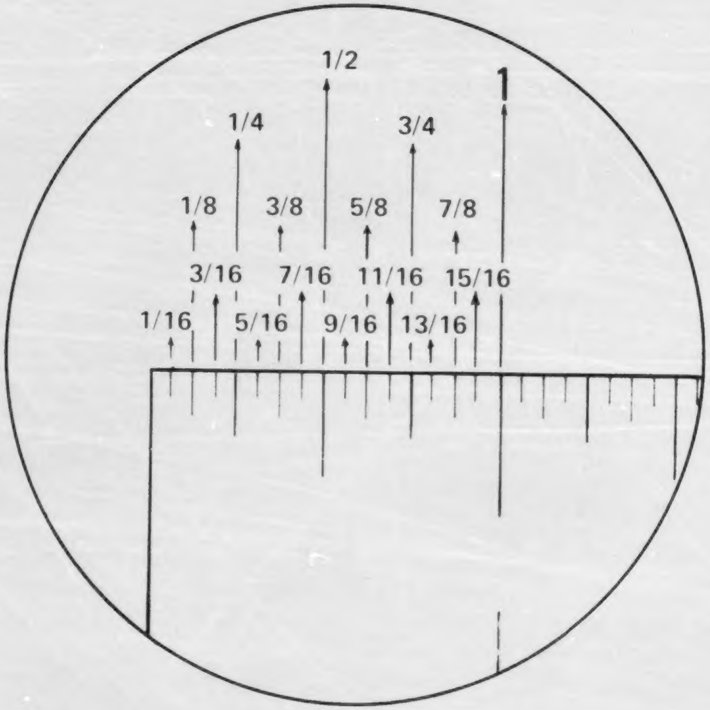


Sixteenths



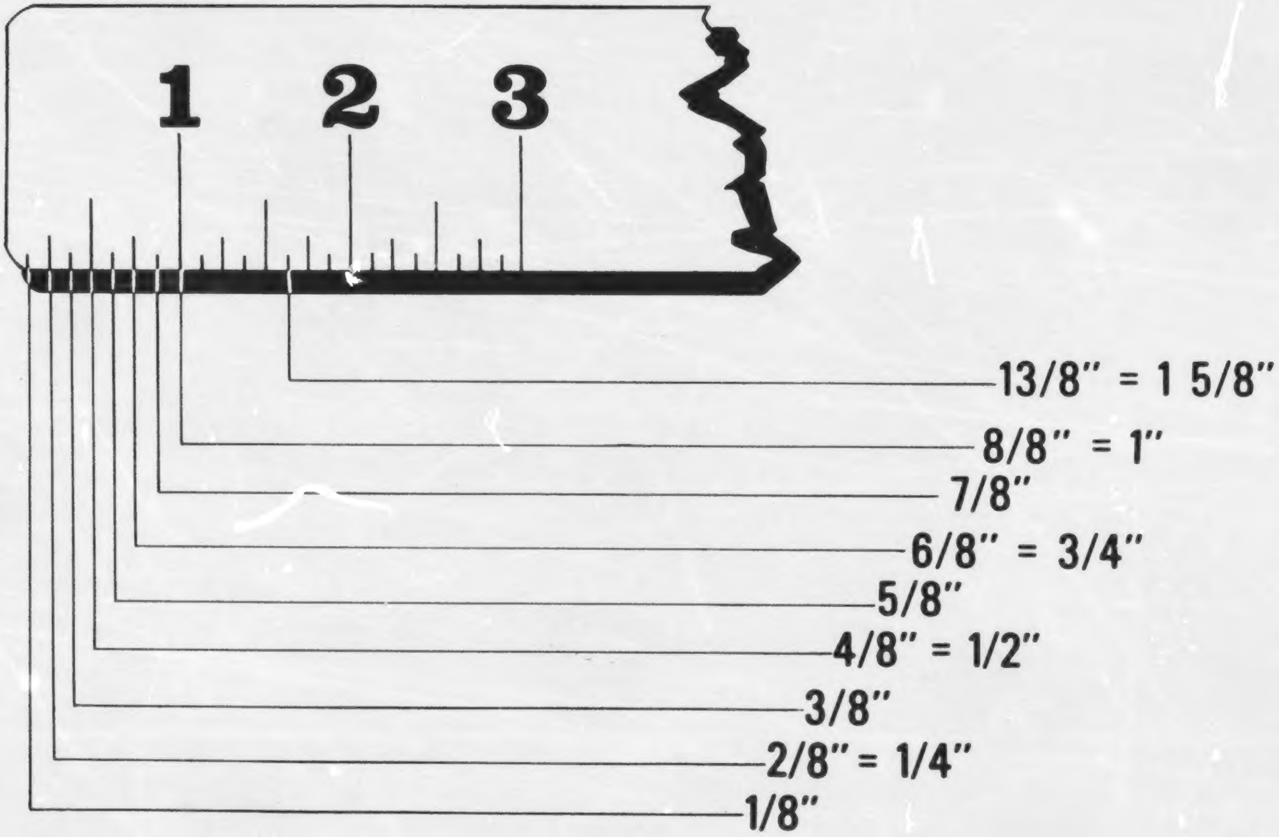
Thirty-Seconds



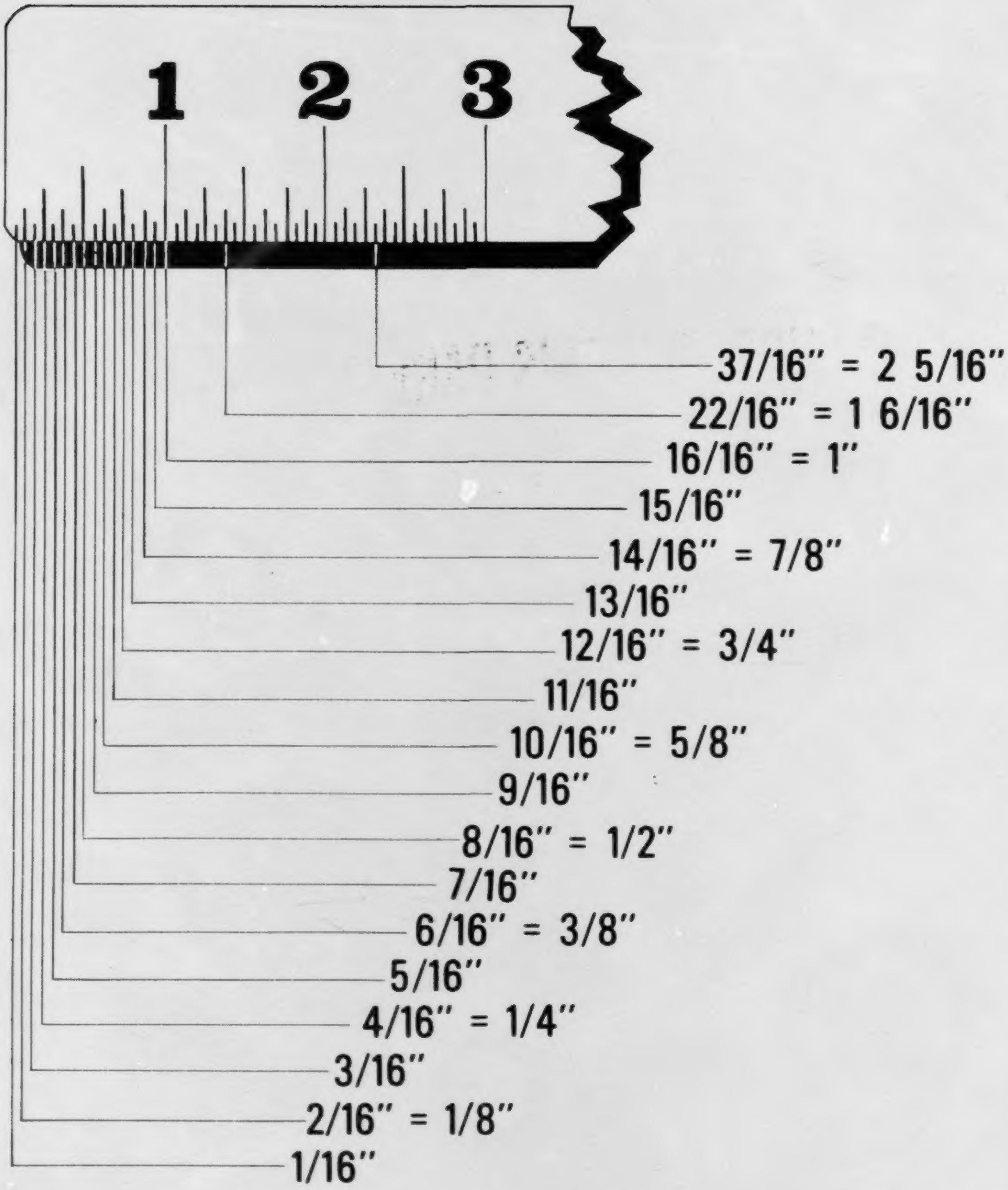

1/2
1
1/4
3/4
1/8
3/8
5/8
7/8
3/16
7/16
11/16
15/16
1/16
5/16
9/16
13/16

Graduations Applied to a Rule

Reading the Eighths Rule


1
2
3
13/8" = 1 5/8"
8/8" = 1"
7/8"
6/8" = 3/4"
5/8"
4/8" = 1/2"
3/8"
2/8" = 1/4"
1/8"

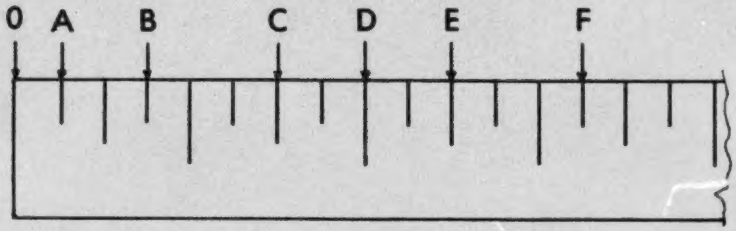
Reading the Sixteenths Rule


1
2
3
37/16" = 2 5/16"
22/16" = 1 6/16"
16/16" = 1"
15/16"
14/16" = 7/8"
13/16"
12/16" = 3/4"
11/16"
10/16" = 5/8"
9/16"
8/16" = 1/2"
7/16"
6/16" = 3/8"
5/16"
4/16" = 1/4"
3/16"
2/16" = 1/8"
1/16"

BLUEPRINTS AND SPECIFICATIONS
UNIT II

ASSIGNMENT SHEET #1--READ A RULE

1. Use the drawing below and read the rule to the nearest one-fourth inch.



a. 0-A ________

b. 0-B ________

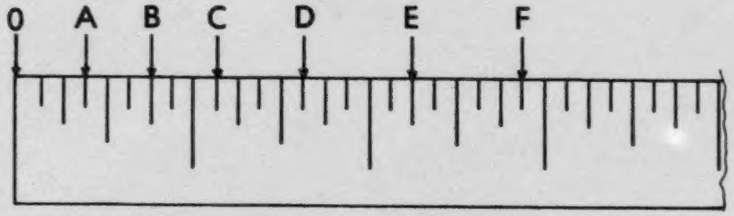
c. 0-C ________

d. 0-D ________

e. 0-E ________

f. 0-F ________

2. Use the drawing below and read the rule to the nearest one-eighth inch.



a. 0-A ________

b. 0-B ________

c. 0-C ________

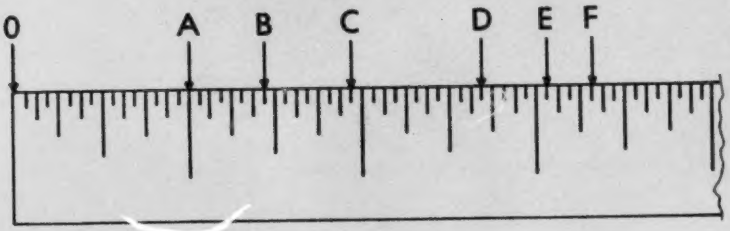
d. 0-D ________

e. 0-E ________

f. 0-F ________

ASSIGNMENT SHEET #1

3. Use the drawing below and read the rule to the nearest one-sixteenth inch.



a. 0-A ____________

b. 0-B ____________

c. 0-C ____________

d. 0-D ____________

e. 0-E ____________

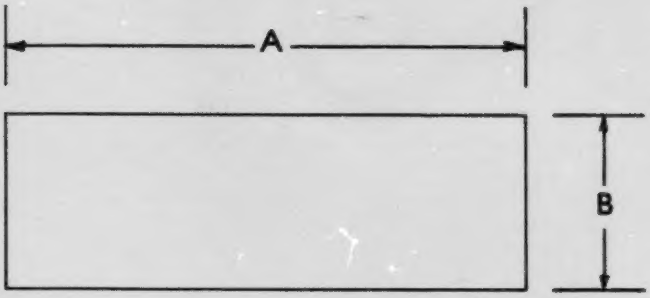
f. 0-F ____________

BLUEPRINTS AND SPECIFICATIONS
UNIT II

ASSIGNMENT SHEET #2--MEASURE OBJECTS USING A RULE

Using a rule with one-sixteenth inch graduations, measure the following objects.

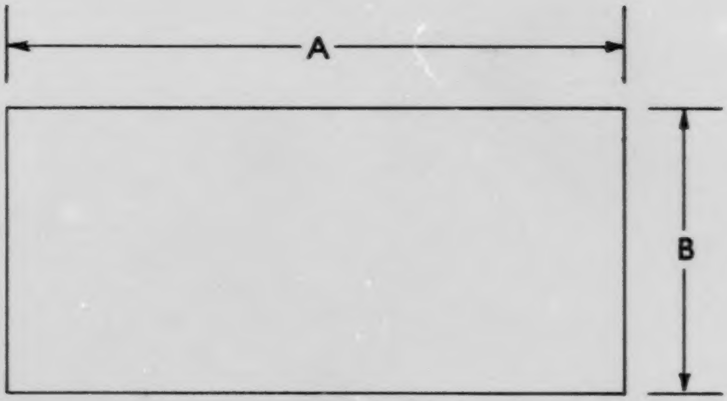
1.



a. Length ________

b. Height ________

2.

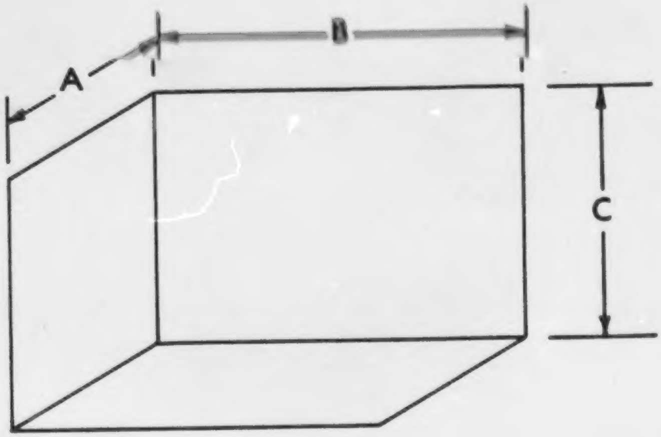


a. Length ________

b. Height ________

ASSIGNMENT SHEET #2

3.

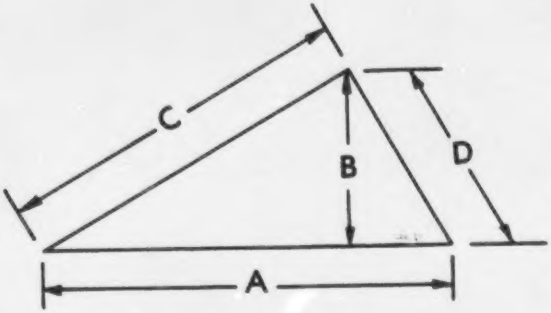


a. Width ____________

b. Length ____________

c. Height ____________

4.



a. Base ____________

b. Height ____________

c. Slope #1 ____________

d. Slope #2 ____________

BLUEPRINTS AND SPECIFICATIONS
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. a. 1/4 inch
   - b. 3/4 inch
   - c. 1 1/2 inch
   - d. 2 inches
   - e. 2 1/2 inches
   - f. 3 1/4 inches
2. a. 3/8 inch
   - b. 3/4 inch
   - c. 1 1/8 inches
   - d. 1 5/8 inches
   - e. 2 1/4 inches
   - f. 2 7/8 inches
3. a. 1 inch
   - b. 1 7/16 inches
   - c. 1 15/16 inches
   - d. 2 11/16 inches
   - e. 3 1/16 inches
   - f. 3 5/16 inches

Assignment Sheet #2

1. a. 3 inches
   - b. 1 inch
2. a. 3 9/16 inches
   - b. 1 5/8 inches

3. a. 1 inch
   b. 2 1/8 inches
   c. 1 7/16 inches
4. a. 2 3/8 inches
   b. 1 inch
   c. 2 1/16 inches
   d. 1 3/16 inches

BLUEPRINTS AND SPECIFICATIONS
UNIT II

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. A detailed drawing of a building as if it were cut through horizontally to show rooms, partitions, windows, doors, stairs, and electrical outlets

_____b. Set of conventional symbols used to depict an object as to size or shape

_____c. An instrument that is graduated in whole units and fractions of units and used in measuring

_____d. A copy of the original detailed drawing

_____e. The arrangement of lines and symbols to indicate the actual size for constructing the object that is represented

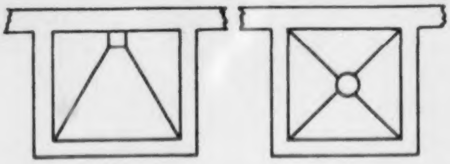
_____f. An arbitrary sign that has been standardized and is used to represent an object, quantity, or method

_____g. A detailed set of written instructions which explain the drawing and become a part of the contract

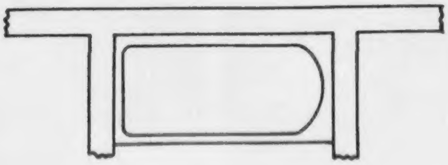
1. Dimensions
2. Floor plan
3. Rule
4. Blueprint lines
5. Specifications
6. Blueprint
7. Symbol

2. Identify blueprint symbols used in residential drawing.

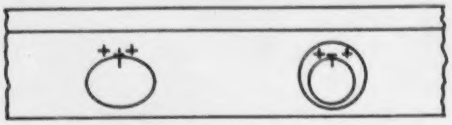
a. Plumbing



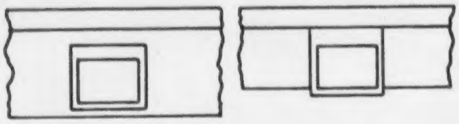
1. ____________________



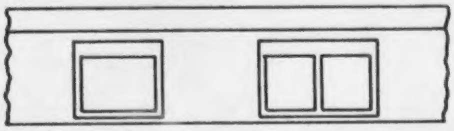
2. ____________________



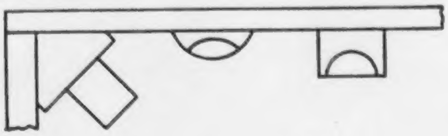
3. ____________________



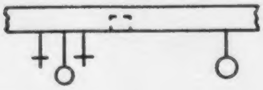
4. ____________________



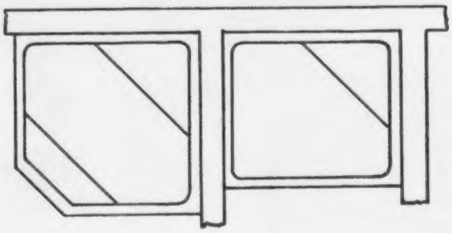
5. __________ 6. __________



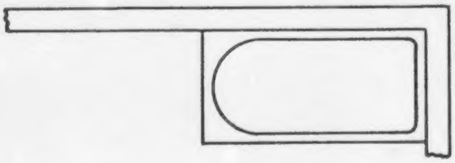
7. ________ 8. ________ 9. ________



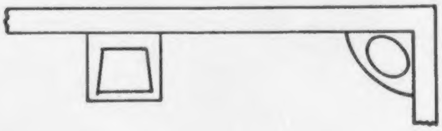
10. ____________________



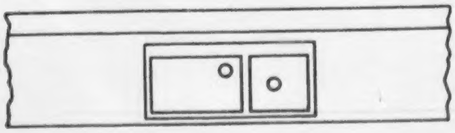
11. __________ 12. __________



13. ____________________



14. __________ 15. __________



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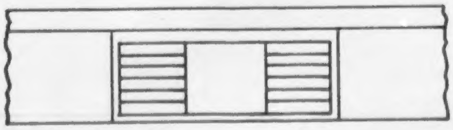

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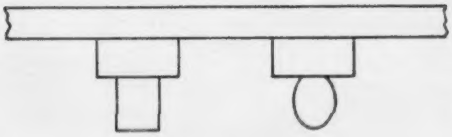

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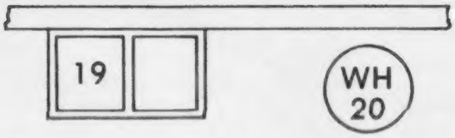
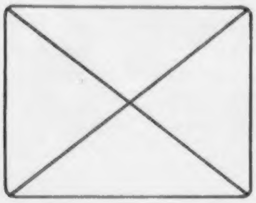
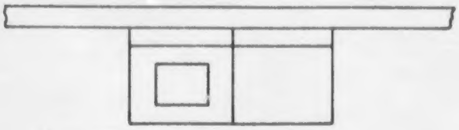


19. __________ 20. __________

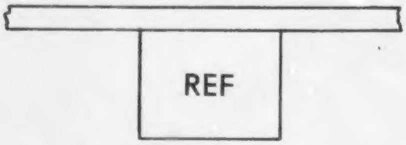


21. ______________________

b. Appliances



1. ______________________



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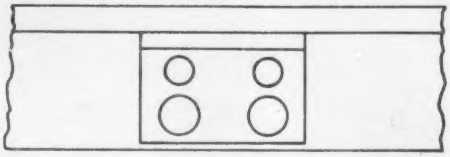
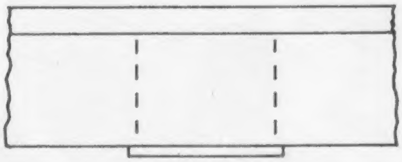


3. ______________________



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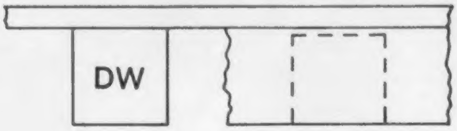

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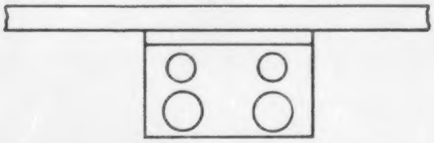

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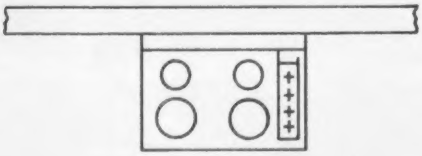
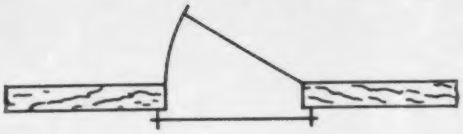
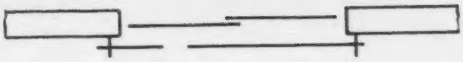


7. ______________________

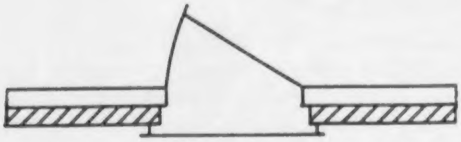
c. Structural symbols



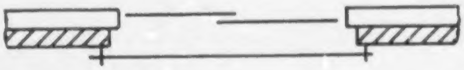
1. ____________________



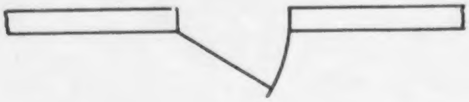
2. ____________________



3. ____________________



4. ____________________



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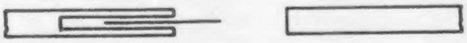
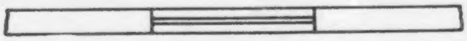
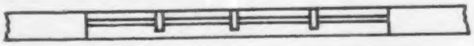


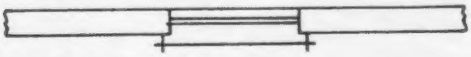
6. ____________________



7. ____________________



8. ____________________

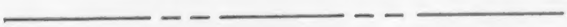


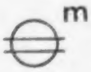
9. ____________________

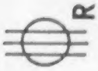
3. Identify the electrical blueprint symbols.

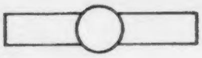
a. S_3 ____________________

b. S_2 ____________________

c.  ____________________

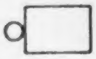
d.  ____________________

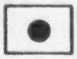
e.  ____________________

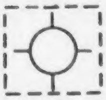
f.  ____________________

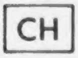
g. S ____________________

h. Sp ____________________

i.  ____________________

j.  ____________________

k.  ____________________

l. 

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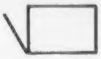
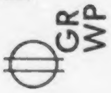
m.  ____________________

n. $\underline{S}$ ____________________

o. 

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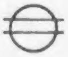
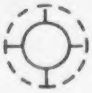
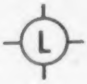
p. Ms ____________________

q.  ____________________

r.  ____________________

s. 

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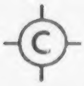
t. 

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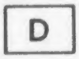
u. S_D ____________________

v. Swp ____________________

w. 

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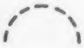
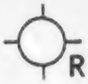
x.  ____________________

y. 

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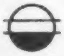
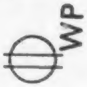
z.  __________

aa. 

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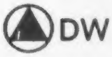
bb. 

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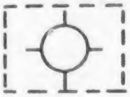
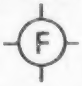
cc.  __________

dd. 

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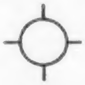
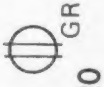
ee.  __________

ff. S_4 __________

gg. 

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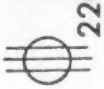
hh. 

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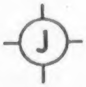
ii. 

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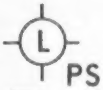
jj. 

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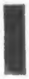
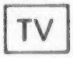
kk.  __________

ll. 

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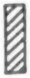
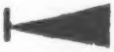
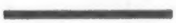
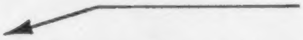
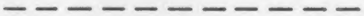
mm.  __________

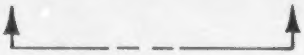
nn.  __________

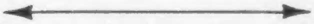
oo.  __________

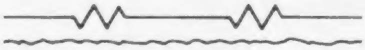
4. Match the names of types of lines to their pictures and descriptions.

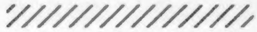
_____a. 
Used to connect a note or dimension to a part of the building

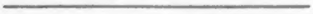
_____b. 
Short dashes used to show lines that are not visible from that view

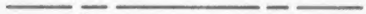
_____c. 
Heavy lines consisting of a series of one long and two short dashes with arrows at each end pointing away from the area that is cut away for the purpose of sectioning

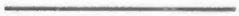
_____d. 
Thin unbroken lines which building dimensions are placed upon

_____e. 
Used when an area cannot or should not be drawn entirely

_____f. 
A series of lines of various shapes or symbols used to depict an area that is a cross section of the whole object and also depicts the type of material to be used in construction

_____g. 
Extend, but do not touch, the object lines and permit dimension lines to be drawn between them

_____h. 
A series of short and long dashes used to designate the center of doors, windows, and circles and to provide a reference point for dimensioning

_____i. 
Show the main outline of the building including exterior walls, inte[illegible] partitions, porches, patios, drivewa[illegible] and interior walls; these lines should be the outstanding lines on a drawing

1. Object lines
2. Center lines
3. Leaders
4. Extension lines
5. Section lines
6. Cutting-plane lines
7. Hidden lines
8. Dimension lines
9. Break lines

5. List five kinds of information commonly found in blueprint specifications.

   a.

   b.

   c.

   d.

   e.

6. List the steps in reading a rule.

   a.

   b.

   c.

7. Read a rule.

8. Measure objects using a rule.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

BLUEPRINTS AND SPECIFICATIONS
UNIT II

ANSWERS TO TEST

1. a. 2
   b. 4
   c. 3
   d. 6
   e. 1
   f. 7
   g. 5

2. a. Plumbing
      1) Showers
      2) Built-in bathtub
      3) Built-in lavatories
      4) Built-in lavatories
      5) Single bowl sink
      6) Double bowl sink
      7) Corner water closet
      8) Wall urinal
      9) Urinal
      10) Shower heads
      11) Square corner bathtub
      12) Built-in square bathtub
      13) Corner bathtub
      14) Wall hung lavatory
      15) Corner lavatory
      16) Shallow bowl sink
      17) Double drainboard sink with cabinet
      18) Toilet stools or water closets
      19) Laundry tubs
      20) Water heater
      21) Furnace

- b. Appliances
  - 1) Washer and dryer
  - 2) Refrigerator or freezer
  - 3) Drop-in range
  - 4) Built-in oven
  - 5) Freestanding and built-in dishwashers
  - 6) Freestanding range
  - 7) Surface cook top
- c. Structural symbols
  - 1) Plan view of exterior door in wood frame wall
  - 2) Plan view of exterior sliding door in wood frame wall
  - 3) Plan view of exterior door in masonry veneer wall
  - 4) Plan view of exterior sliding door in masonry veneer wall
  - 5) Plan view of interior hinged door
  - 6) Plan view of interior pocket door
  - 7) Single window in frame wall
  - 8) Multiple windows in frame wall
  - 9) Plan view of double hung window in frame wall

3.
- a. Three way switch
- b. Double pole switch
- c. Low voltage wire
- d. Receptacle outlet other than duplex
- e. Range outlet
- f. Fluorescent light
- g. Single pole switch
- h. Switch with pilot light
- i. Bell
- j. Push button
- k. Square recessed light (size varies)

l. Chime

m. Buzzer

n. Switch for low voltage system

o. Weatherproof grounding type duplex receptacle outlet

p. Low voltage master switch

q. Duplex receptacle outlet

r. Round recessed light (size varies)

s. Lampholder

t. Clock outlet

u. Automatic door switch

v. Weatherproof switch

w. Electric door opener

x. Switch leg indicator

y. Relay equipped lighting outlet

z. Split wired receptacle outlet

aa. Weatherproof duplex outlet

bb. Special--Must be explained in the key to the symbols

cc. Rectangular recessed light (size varies)

dd. Fan outlet

ee. Lighting outlet

ff. Four way switch

gg. Grounding type duplex receptacle outlet

hh. 220 volt outlet

ii. Junction box

jj. Lampholder with pull switch

kk. Lighting distribution panel

ll. T.V. outlet

mm. Master power service panel

nn. Telephone

oo. Baseboard heat

4. a. 3

b. 7

c. 6

d. 8

e. 9

f. 5

g. 4

h. 2

i. 1

5. Any five of the following:

a. Sizes

b. Types and quality of building materials

c. Methods of construction

d. Material lists

e. Owner's name and address

f. Contractor's name and address

g. Location of new structure

h. Completion date

i. Contractor's bid

j. Guarantees

k. Blueprint number

6. a. Determine the graduations per inch on rule

b. Determine inches and fractions of inches

c. Determine the feet and add inches and fractions of inches

7. Evaluated to the satisfaction of the instructor

8. Evaluated to the satisfaction of the instructor

EQUIPMENT
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify boxes, devices, covers and plates, supports and anchors, screws, bolts, nuts, nails, connectors, terminals, and lugs commonly found in residential wiring. The student should also be able to list design features that need to be considered when selecting boxes and factors to consider when selecting connectors, terminals, and lugs. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Identify boxes used in residential wiring.
2. List design features that need to be considered when selecting boxes.
3. Identify devices commonly used in residential wiring.
4. Identify covers and plates used in residential wiring.
5. Identify common supports and anchors.
6. Identify common screws, bolts, nuts, and nails.
7. Identify common connectors, terminals, and lugs.
8. List four factors to consider when selecting connectors, terminals, and lugs.

EQUIPMENT
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information sheet.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Show student examples of equipment.

  G. Take a field trip to a wholesale supply house.

  H. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Device Boxes

    2. TM 2--Octagon and Square Boxes

    3. TM 3--Box Design Features

    4. TM 4--Box Design Features (Continued)

    5. TM 5--Common Residential Receptacles

6. TM 6--Switches
7. TM 7--Combination Devices and Sockets
8. TM 8--Box Covers
9. TM 9--Exposed Work Raised Square Covers
10. TM 10--Wall Plates
11. TM 11--Handy Box Covers
12. TM 12--Common Supports and Anchors
13. TM 13--Screws, Bolts, and Nuts
14. TM 14--Nails
15. TM 15--Connectors, Terminals, and Lugs

D. Test

E. Answers to test

II. References:

A. *Residential Carpentry*. Curriculum and Instructional Materials Center: Stillwater, Oklahoma.

B. *Holub Catalog No. 23*. Sycamore, Illinois: ITT Holub Industries.

C. *Raco Steel* Box Catalog No. B774, South Bend, Indiana: Raco, Inc.

D. *Leviton Catalog D-100*. Brooklyn, New York: Leviton Manufacturing Co.

EQUIPMENT
UNIT I

INFORMATION SHEET

I. Boxes (Transparencies 1 and 2)

A. Device boxes

(NOTE: Most boxes can be purchased in either metal or nonmetallic composition (fiber, plastic, nylon or rubber.)

1. Handy boxes
    a. Handy box (one piece molded construction)
    b. Handy box (one piece welded construction)
    c. Extension

       (NOTE: Extensions can be purchased for all types of boxes.)
    d. Bracket box
2. Switch boxes
    a. Bracket nongangable with cable clamps
    b. Gangable with nail holes
    c. Gangable with ears and cable clamps
    d. Gangable bracket box with cable clamps
    e. With dry wall grips, cable clamps and ears
    f. Beveled corner with cable clamps
    g. Gangable with grounding pigtail
    h. Nail-on
    i. Solid two gang bracket

       (NOTE: These are just a few of the types available; configurations such as dry wall grips, brackets, pigtails and factory nail assemblies can be purchased on almost any size box.)

INFORMATION SHEET

B. Octagon boxes

(NOTE: Octagon boxes, like switch boxes, can be either metallic or nonmetallic; like switch boxes, they can be purchased in many different depths.)

1. With cable clamps and nail holes
2. With bracket
3. Extension
4. With cable clamps and grounding pigtail
5. With bar hanger and cable clamps

C. Square boxes

(NOTE: Square boxes are usually used in conjunction with covers designed for special purposes.)

1. Square box (one piece molded construction)
2. Square box (one piece welded construction)
3. With bracket
4. With bracket, cable clamps and grounding pigtail
5. Extension

II. Design features for boxes (Transparencies 3 and 4)

A. Type of box needed

(NOTE: Be sure and purchase a box that will meet all the installation needs and requirements.)

B. Size of box needed

(NOTE: NEC requirements for conductor fill must always be considered when selecting boxes.)

C. Type of clamps (if needed)

D. Type of bracket (if needed)

E. Type, number, and position of openings

INFORMATION SHEET

F. Grounding considerations (if box is metal type)

(NOTE: A means shall be provided in each metallic box, designed for use with nonmetallic raceways and cable systems for the connection of an equipment grounding conductor.)

III. Devices (Transparencies 5, 6, and 7)

(NOTE: Manufacturers make different grades of devices. Price and quality vary with the grades. Specification grade is the most expensive. Before installing devices check the grade requested in the job bid.)

A. Receptacles

1. Range receptacle--125/250v; 50 amp
2. Dryer recptacle--125/250v; 30 amp
3. Air-conditioner receptacle--250v; 20 amp
4. Duplex grounding receptacle--125v; 15 amp
5. Dual voltage receptacle--125/250v; 20 amp
6. Air-conditioning receptacle--250v; 30 amp

B. Switches

1. Single pole
2. Three way
3. Four way
4. Double pole
5. Dimmer
6. Low voltage push button

C. Combination devices

1. Switch and receptacle

   (NOTE: This can be a single pole or three way with a grounding type receptacle.)

2. Two switches

   (NOTE: This can be two single poles, two three ways, or a single pole and a three way.)

INFORMATION SHEET

3. Switch and pilot light

   (NOTE: This can be either a single pole or three way with either a neon or incandescent light.)

D. Sockets

1. Keyless pigtail
2. Keyless cover
3. Pull chain cover
4. Pull chain cover with grounding type receptacle

IV. Covers and plate (Transparencies 8, 9, and 10)

A. Round covers

1. Flat blank
2. Flat with knockout
3. Raised with knockout
4. Raised for single device
5. Raised open
6. Flat toggle
7. Flat duplex receptacle
8. Flat single receptacle

B. Square covers

1. Flat blank
2. Flat blank with knockout
3. Raised open
4. Flat single device
5. Raised single device
6. Flat two device
7. Raised two device

INFORMATION SHEET

C. Exposed work square covers
    1. Single toggle switch
    2. Single receptacle
    3. Duplex receptacle
    4. Two toggle switches
    5. Two single receptacles
    6. Toggle and duplex receptacle

D. Wall plates
    1. Single toggle
    2. Duplex receptacle
    3. Two toggle
    4. Single toggle and duplex receptacle
    5. Single toggle and single receptacle
    6. Two toggle and duplex receptacle
    7. Weatherproof single receptacle
    8. Weatherproof duplex receptacle (horizontal)
    9. Weatherproof duplex receptacle with screw covers
    10. Weatherproof duplex receptacle (vertical)

E. Handy box covers (Transparency 11)
    1. Blank
    2. Single receptacle
    3. Duplex receptacle
    4. Single toggle

V. Common supports and anchors (Transparency 12)
    A. Bar hanger
    B. Switch box supports

INFORMATION SHEET

C. One hole strap

D. Two hole strap

E. Plastic anchors

F. Lead anchor

G. Toggle bolt

H. Molly bolt

I. Drive pin

J. Drive stud

K. Lag screw shield

L. Expansion bolt

VI. Common screws, bolts, nuts, and nails (Transparencies 13 and 14)

A. Screws

1. Sheet metal screw
2. Self drilling screw
3. Wood screw
4. Machine screw
5. Set screw

B. Bolts

1. Carriage bolt
2. Hex head bolt
3. Hex socket head bolt

C. Nuts

1. Acorn
2. Spring
3. Wing
4. Fixture

INFORMATION SHEET

5. Single thread

6. Hex (plain)

D. Nails

1. Box or common

(NOTE: Common nails have gripping creases on the shank under the head and are slightly larger in diameter than box nails.)

2. Masonry

3. Galvanized roofing nail

VII. Connectors, terminals, and lugs (Transparency 15)

A. Connectors

1. Crimp sleeve

2. Set screw

3. Split bolt

4. Service entrance

5. Wire nuts

6. Crimp type butt connectors

B. Terminals

1. Ring

2. Spade

3. Easy disconnect

C. Lugs

1. Single terminal lug

2. Twin terminal lug

INFORMATION SHEET

VIII. Factors to consider when selecting connectors, terminals and lugs

A. Job to be done

(NOTE: Using the appropriate equipment saves money and is a must for a job correctly done.)

B. Type of conductors involved

(NOTE: Some equipment is suitable for either copper or aluminum use. A poor connection will exist if aluminum conductors are joined or terminated with lugs not suitable for aluminum use.)

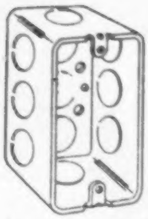
C. Size of conductors involved

(NOTE: Never cut conductor strands to get a conductor to fit in equipment.)

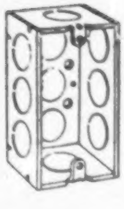
D. Number of conductors involved

DEVICE BOXES

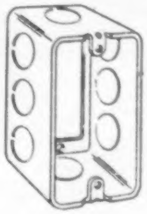
HANDY BOXES



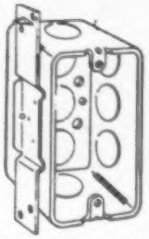
HANDY BOX
(MOLDED
CONSTRUCTION)



HANDY BOX
(WELDED
CONSTRUCTION)

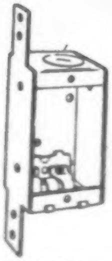


EXTENSION

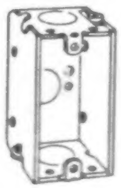


BRACKET BOX

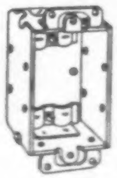
SWITCH BOXES



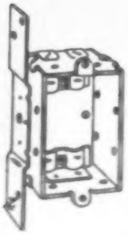
BRACKET
NON-GANGABLE
WITH
CABLE CLAMPS



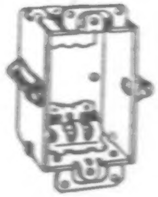
GANGABLE
WITH
NAIL HOLES



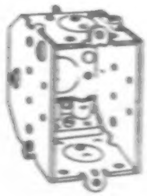
GANGABLE
WITH
EARS AND
CABLE CLAMPS



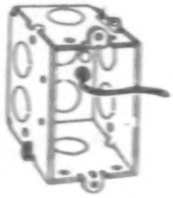
GANGABLE
BRACKET BOX
WITH
CABLE CLAMPS



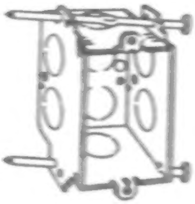
WITH
DRYWALL GRIPS,
CABLE CLAMPS
AND EARS



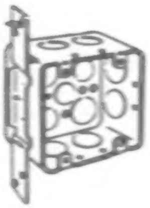
BEVELED
CORNER
WITH
CLAMPS



GANGABLE
WITH
GROUNDING
PIGTAIL



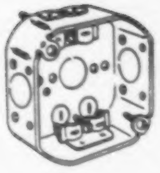
NAIL ON



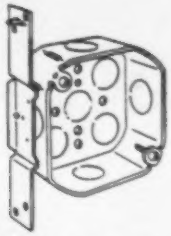
SOLID
TWO GANG
BRACKET

OCTAGON AND SQUARE BOXES

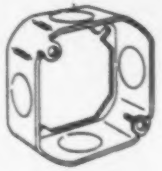
OCTAGON BOXES



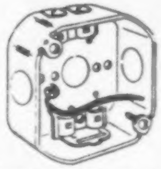
WITH CABLE CLAMPS AND NAIL HOLES



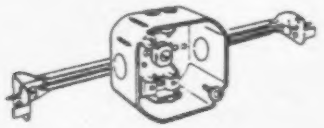
WITH BRACKET



EXTENSION

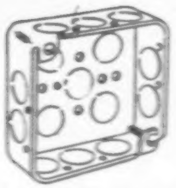


WITH CABLE CLAMPS AND GROUNDING PIGTAIL

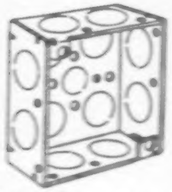


WITH BAR HANGER AND CABLE CLAMPS

SQUARE BOXES



SQUARE BOX (ONE PIECE MOLDED CONSTRUCTION)



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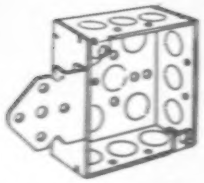
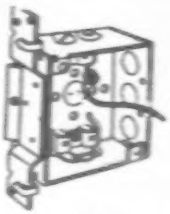
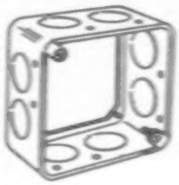


WITH BRACKET



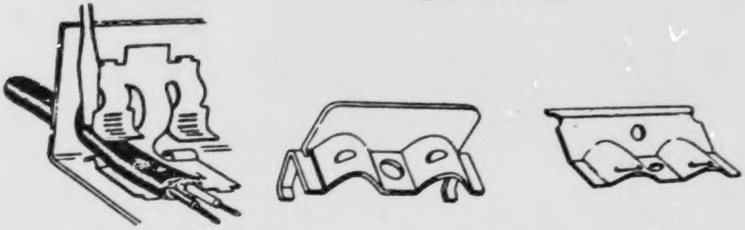
WITH BRACKET, CABLE CLAMPS AND GROUNDING PIGTAIL



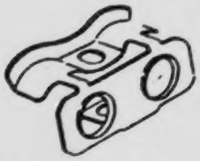
EXTENSION

BOX DESIGN FEATURES

CLAMPS

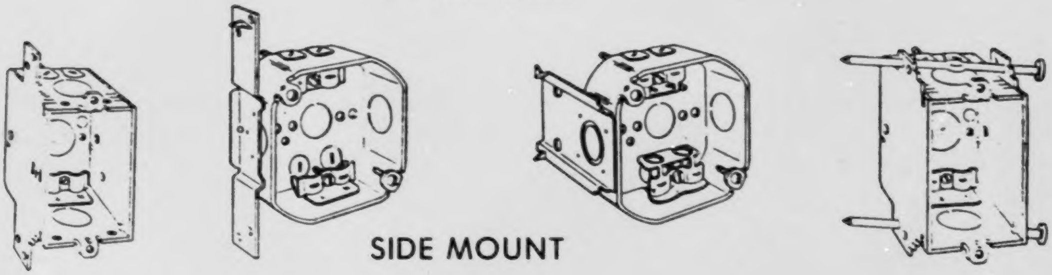


NONMETALLIC CABLE CLAMPS

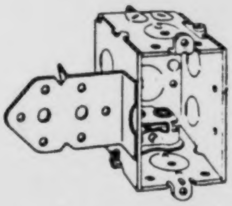


METALLIC
CABLE CLAMP

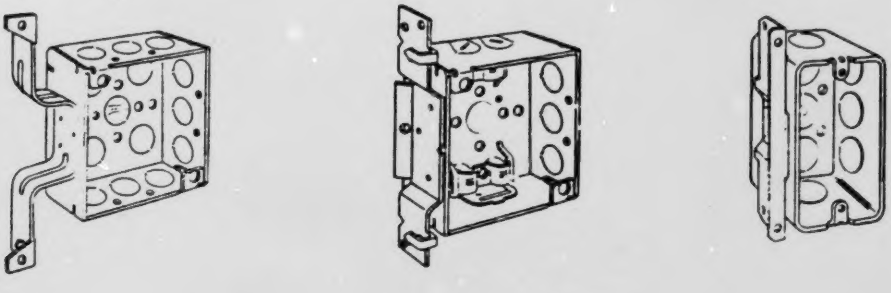
BRACKETS



SIDE MOUNT



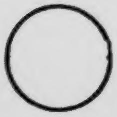
FRONT MOUNT



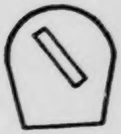
SIDE AND FRONT MOUNT

BOX DESIGN FEATURES (Continued)

BOX OPENINGS

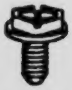


KNOCKOUT

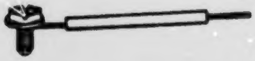


PRI-OUT

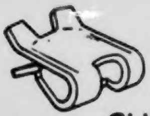
GROUNDING EQUIPMENT



SCREW

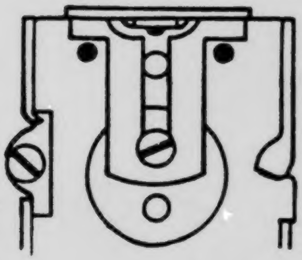


SCREW WITH PIGTAIL

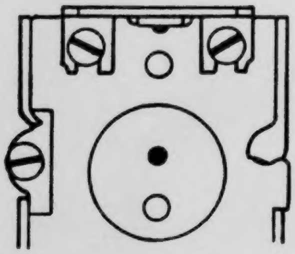


CLIP

PLASTER EARS

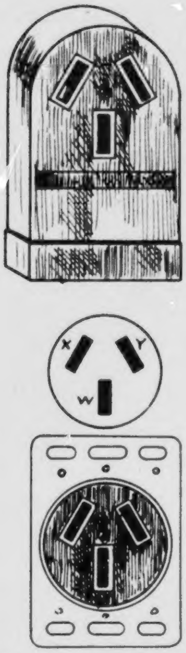


ONE SCREW DESIGN

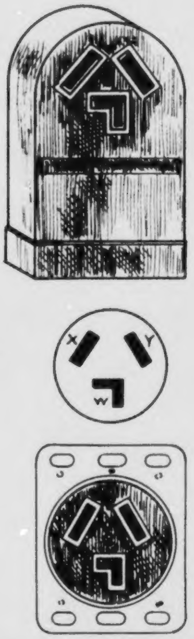


TWO SCREW DESIGN

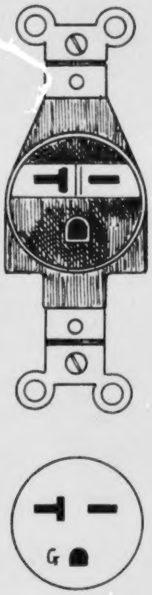
COMMON RESIDENTIAL RECEPTACLES



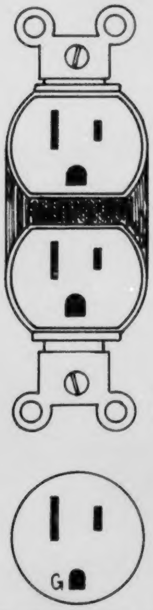
RANGE RECEPTACLE
125/250v, 50 amp



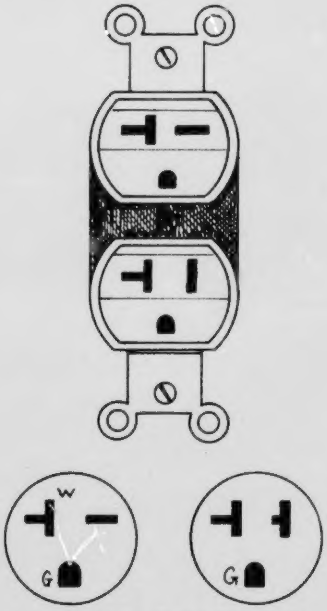
DRYER RECEPTACLE
125/250v, 30 amp



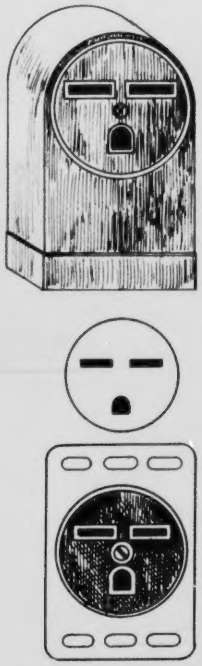
AIR CONDITIONER RECEPTACLE
250v, 20 amps



DUPLEX GROUNDING RECEPTACLE
125v, 15 amp



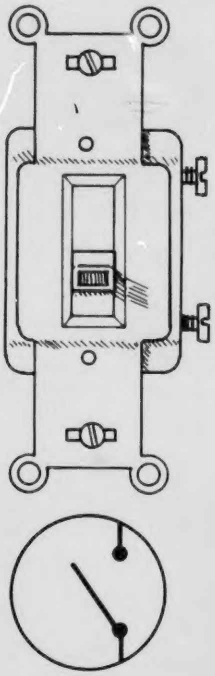
DUAL VOLTAGE RECEPTACLE
125/250v, 20 amp



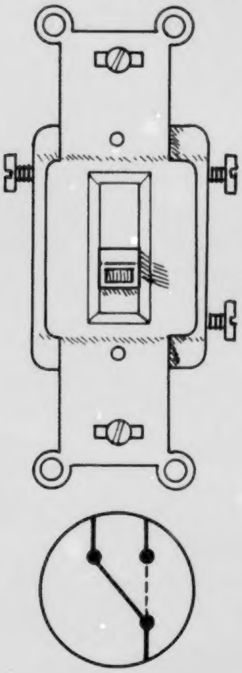
AIR CONDITIONING RECEPTACLE
250 volt, 30 amp

SWITCHES

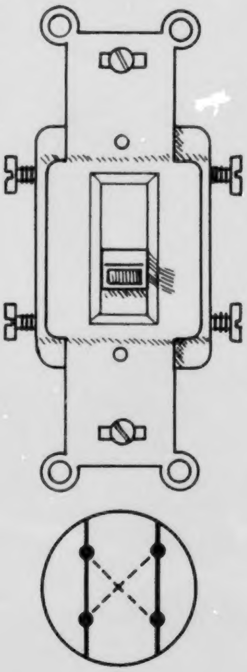
SINGLE POLE



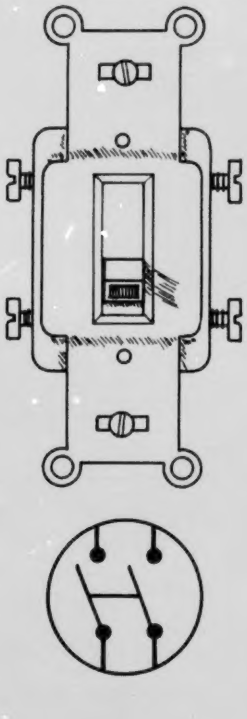
THREE WAY



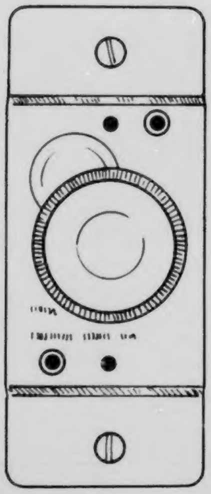
FOUR WAY



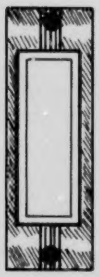
DOUBLE POLE



DIMMER

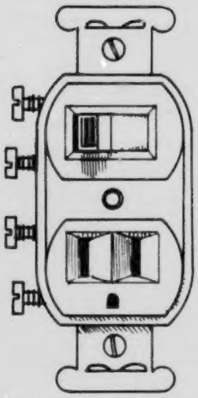


LOW VOLTAGE
PUSH BUTTON

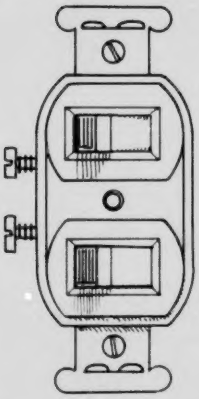


COMBINATION DEVICES AND SOCKETS

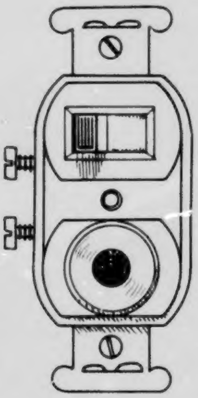
COMBINATION DEVICES



SWITCH AND RECEPTACLE

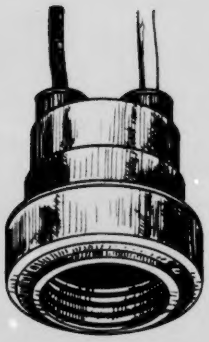


TWO SWITCHES

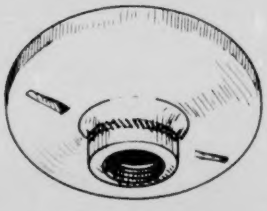


SWITCH AND PILOT LIGHT

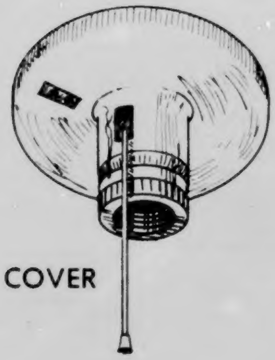
SOCKETS



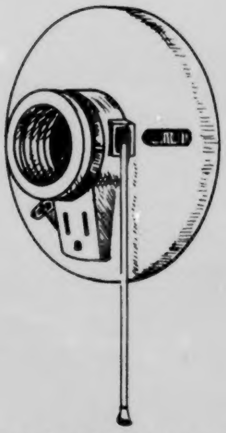
KEYLESS PIGTAIL



KEYLESS COVER



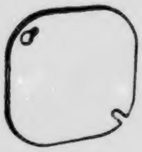
PULL CHAIN COVER



PULL CHAIN COVER
WITH
GROUNDING TYPE
RECEPTACLE

BOX COVERS

ROUND COVERS



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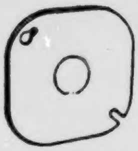
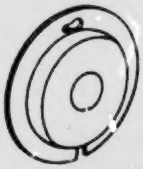
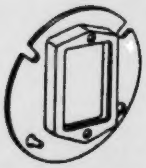


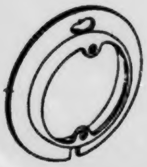
FLAT WITH
KNOCKOUT



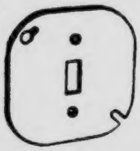
RAISED WITH
KNOCKOUT



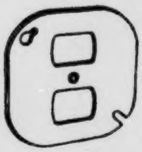
RAISED FOR
SINGLE DEVICE



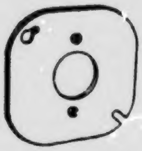
RAISED
OPEN



FLAT
TOGGLE

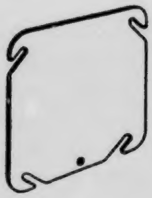


FLAT DUPLEX
RECEPTACLE



FLAT SINGLE
RECEPTACLE

SQUARE COVERS



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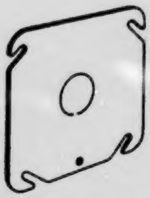

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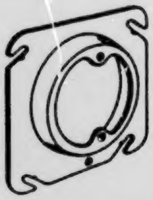
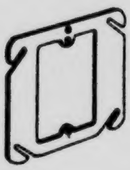
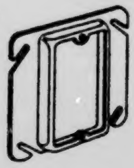
WITH
KNOCKOUT



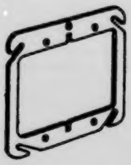
RAISED OPEN



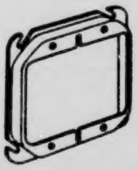
FLAT
SINGLE DEVICE



RAISED
SINGLE DEVICE

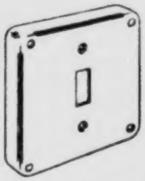


FLAT
TWO DEVICE

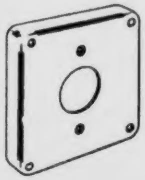


RAISED
TWO DEVICE

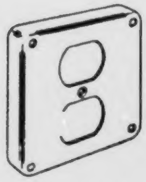
EXPOSED WORK RAISED SQUARE COVERS



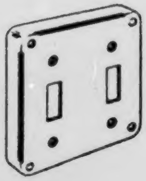
SINGLE TOGGLE



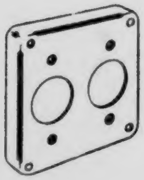
SINGLE RECEPTACLE



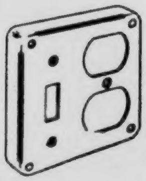
DUPLEX RECEPTACLE



TWO TOGGLE

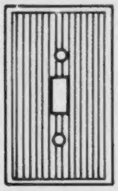


TWO RECEPTACLE

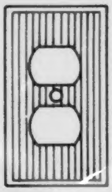


TOGGLE AND
DUPLEX RECEPTACLE

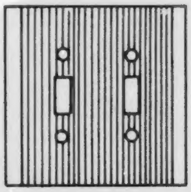
WALL PLATES



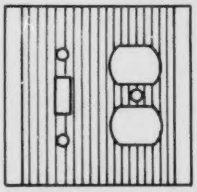
SINGLE TOGGLE



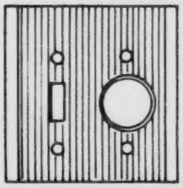
DUPLEX RECEPTACLE



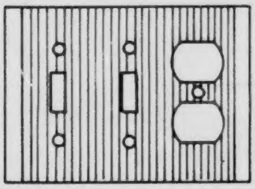
TWO TOGGLE



SINGLE TOGGLE AND DUPLEX RECEPTACLE

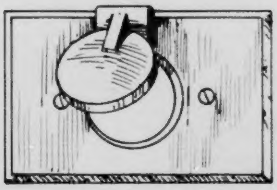


SINGLE TOGGLE AND SINGLE RECEPTACLE

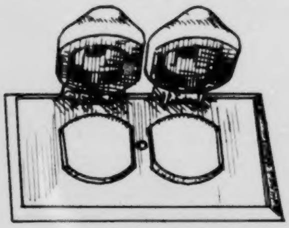


TWO TOGGLE AND DUPLEX RECEPTACLE

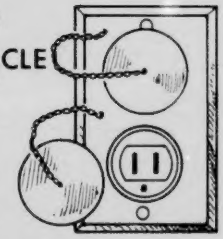
WEATHERPROOF SINGLE RECEPTACLE

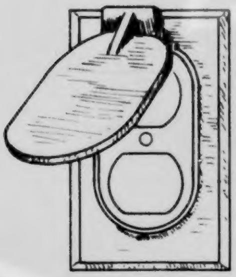


WEATHERPROOF DUPLEX RECEPTACLE (HORIZONTAL)



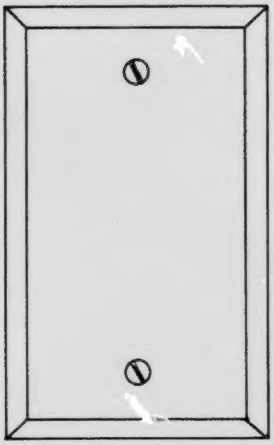
WEATHERPROOF DUPLEX RECEPTACLE WITH SCREW COVERS





WEATHERPROOF DUPLEX RECEPTACLE (VERTICAL)

HANDY BOX COVERS



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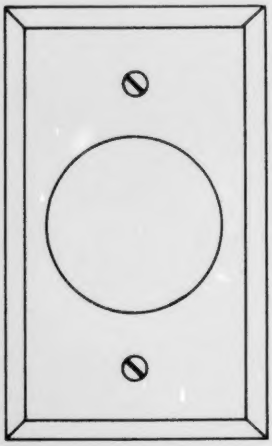
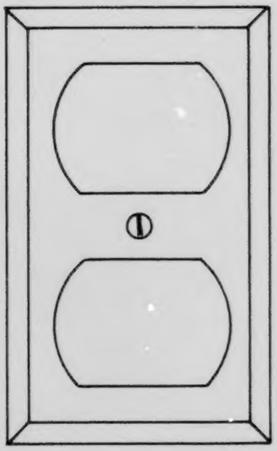
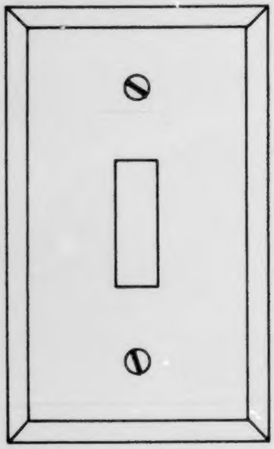


SINGLE RECEPTACLE

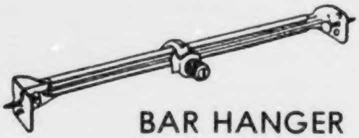


DUPLEX RECEPTACLE

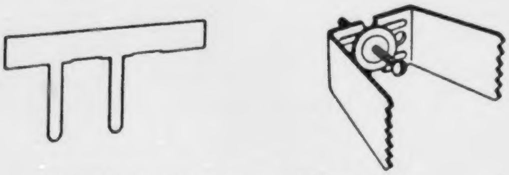


SINGLE TOGGLE

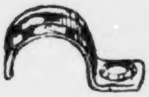
COMMON SUPPORTS AND ANCHORS



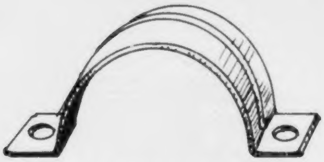
BAR HANGER



SWITCH BOX SUPPORTS

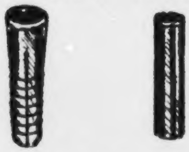


ONE HOLE STRAP

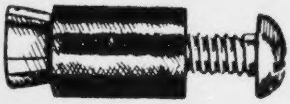


TWO HOLE STRAP

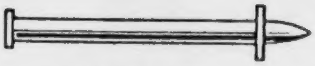
FLANGE PLUG



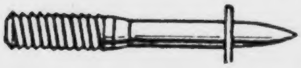
PLASTIC ANCHORS



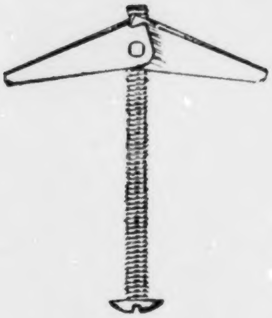
LEAD ANCHOR



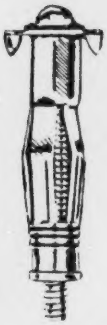
DRIVE PIN



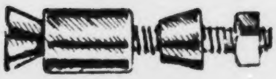
DRIVE STUD



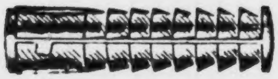
TOGGLE BOLT



MOLLY BOLT



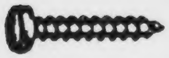
EXPANSION BOLT

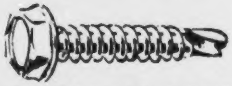


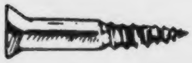
LAG SCREW SHIELD

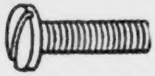
SCREWS, BOLTS, AND NUTS

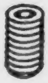
SCREWS


SHEET METAL SCREW

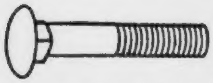

SELF DRILLING SCREW

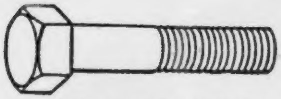

WOOD SCREW

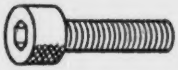

MACHINE SCREW


SET SCREW

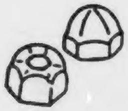
BOLTS

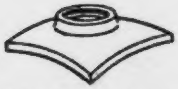

CARRIAGE BOLT

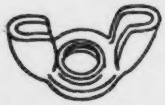

HEX HEAD BOLT

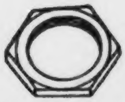

HEX SOCKET HEAD BOLT

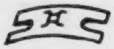
NUTS

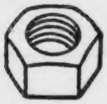

ACORN NUTS


SPRING NUT


WING NUT

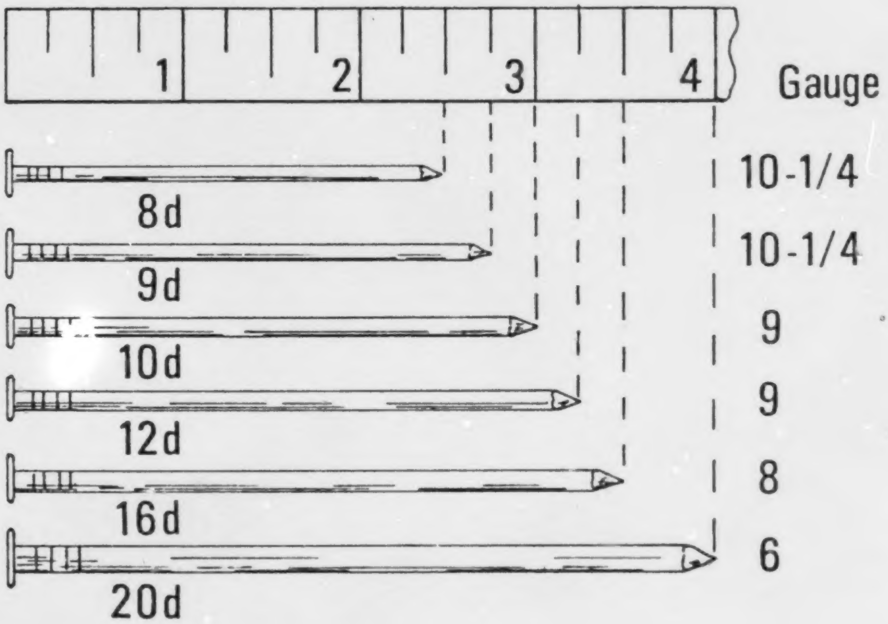

FIXTURE NUT

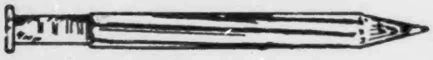

SINGLE THREAD NUT


HEX HEAD NUT

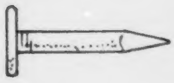
NAILS

BOX AND COMMON NAILS


1
2
3
4
Gauge
10-1/4
8d
10-1/4
9d
9
10d
9
12d
8
16d
6
20d

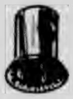


MASONRY NAIL

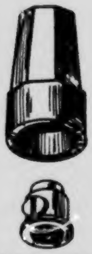


GALVANIZED ROOFING NAIL

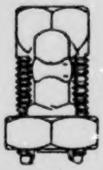
CONNECTORS, TERMINALS, AND LUGS



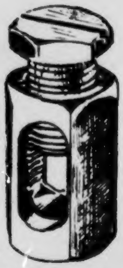
CRIMP
SLEEVE



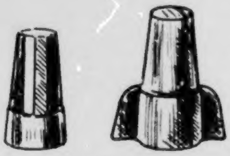
SET SCREW



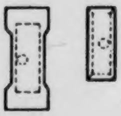
SPLIT BOLT



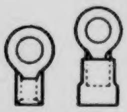
SERVICE
ENTRANCE



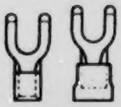
WIRE NUTS



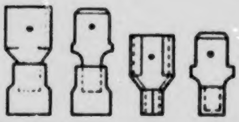
CRIMP TYPE
BUTT
CONNECTORS



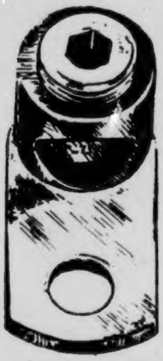
RING



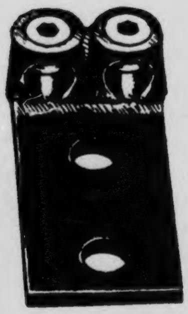
SPADE



QUICK DISCONNECT



SINGLE TERMINAL



TWIN TERMINAL

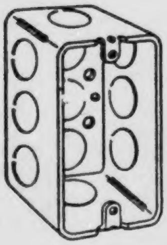
EQUIPMENT
UNIT I

NAME ____________________

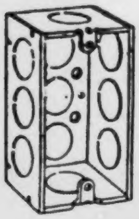
TEST

1. Identify the following boxes used in residential wiring.

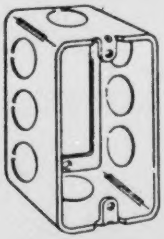
HANDY BOXES



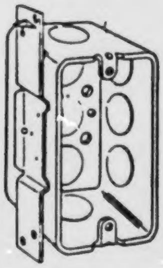
a. ____________



b. ____________

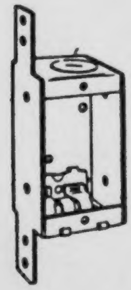


c. ____________

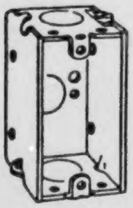


d. ____________

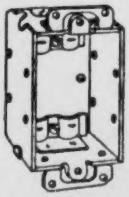
SWITCH BOXES



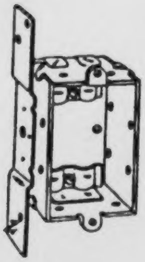
e. ____________



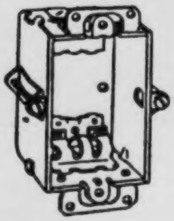
f. ____________



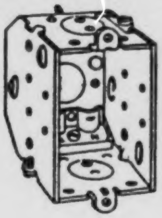
g. ____________



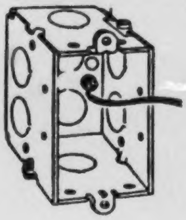
h. ____________



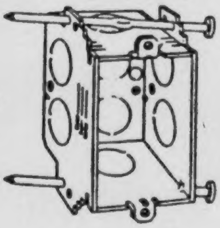
i. ____________



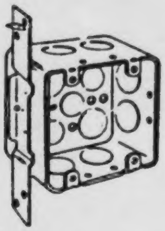
j. ____________



k. ____________

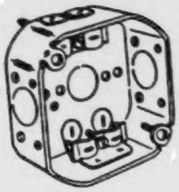


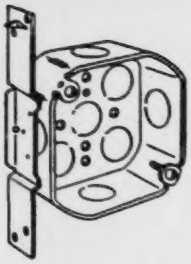
l. ____________



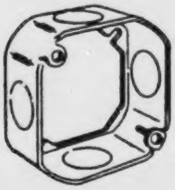
m. ____________

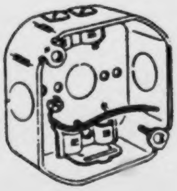
OCTAGON BOXES

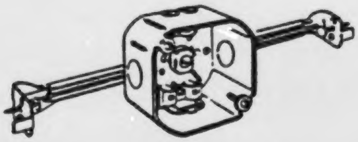




n. ______________________ o. ______________________

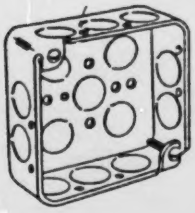


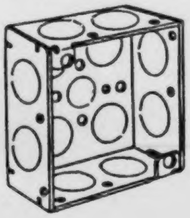


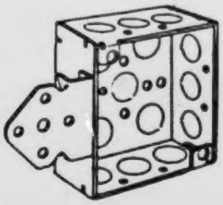


p. ____________ q. ____________ r. ____________

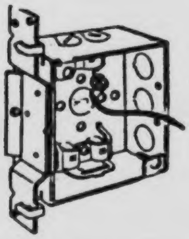
SQUARE BOXES

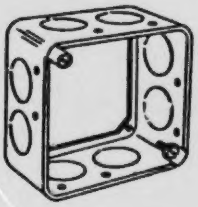






s. ____________ t. ____________ u. ____________





v. ____________ w. ____________

2. List six design features that need to be considered when selecting boxes.

a.

b.

c.

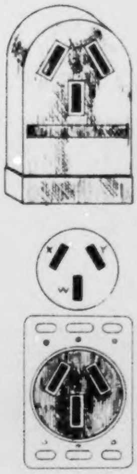
d.

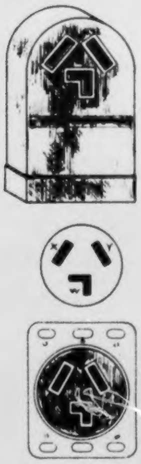
e.

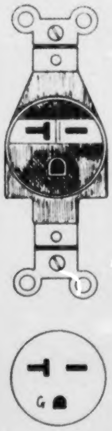
f.

3. Identify the following devices commonly used in residential wiring.

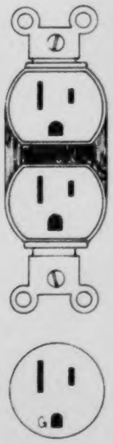
RECEPTACLES

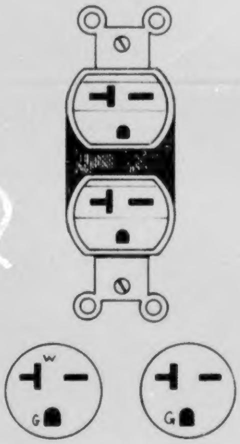


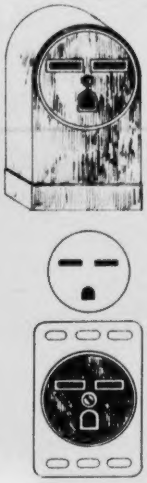




a. ____________ b. ____________ c. ____________

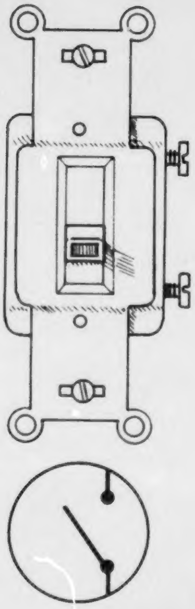




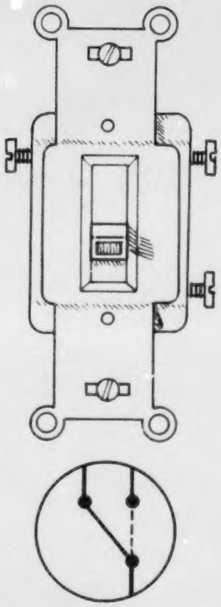


d. ____________ e. ____________ f. ____________

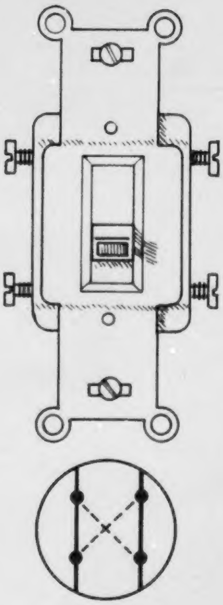
SWITCHES



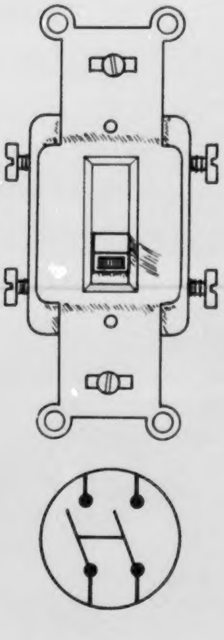
g. ____________________



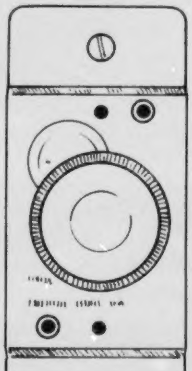
h. ____________________



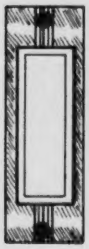
i. ____________________



j. ____________________

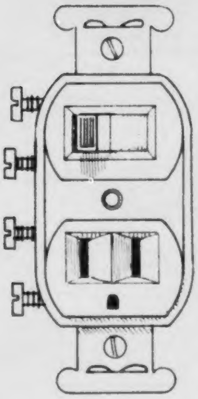


k. ____________________

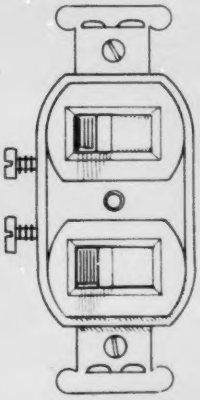


l. ____________________

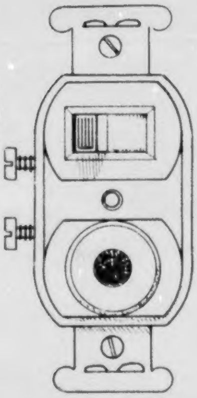
COMBINATION DEVICES



m. ______________

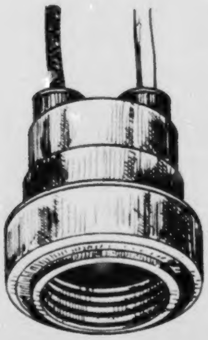


n. ______________

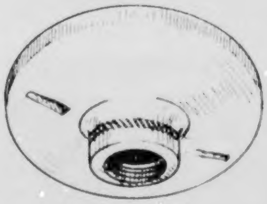


o. ______________

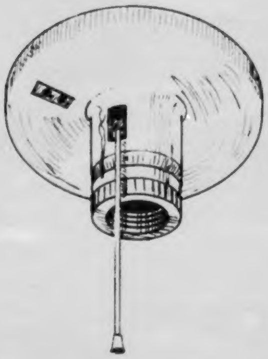
SOCKETS



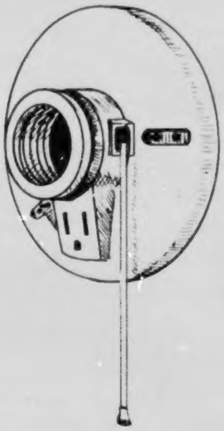
p. ______________



q. ______________



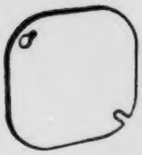
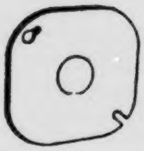
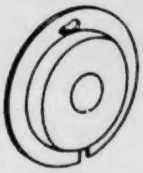
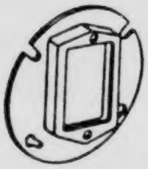
r. ______________



s. ______________

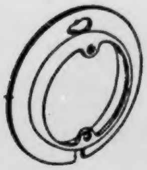
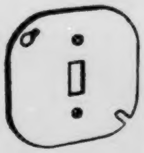
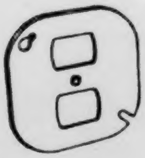
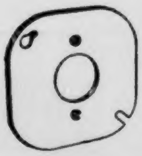
4. Identify the following covers and plates used in residential wiring.

ROUND COVERS

a. ______________ b. ______________ c. ______________ d. ______________

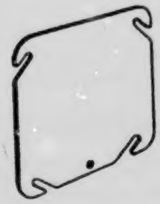
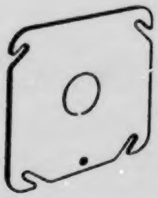
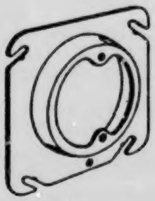
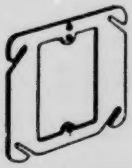
______________ ______________ ______________ ______________

e. ______________ f. ______________ g. ______________ h. ______________

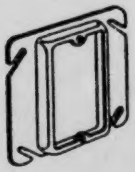
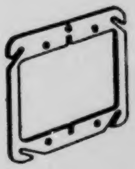
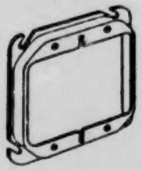
______________ ______________ ______________ ______________

SQUARE COVERS

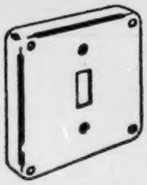
i. ______________ j. ______________ k. ______________ l. ______________

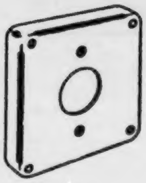
______________ ______________ ______________ ______________

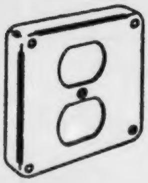




m. ____________________ n. ____________________ o. ____________________

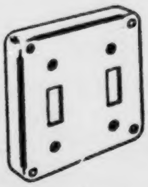
EXPOSED WORK SQUARE COVERS

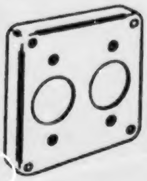


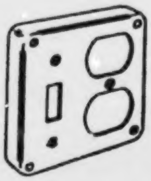




p. ______________ q. ______________ r. ______________

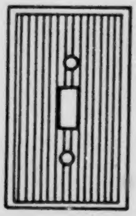


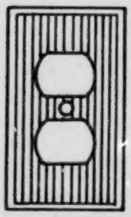


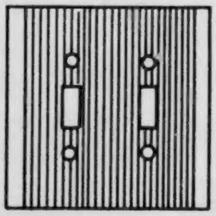


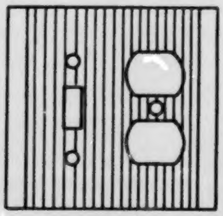
s. ______________ t. ______________ u. ______________

WALL PLATES



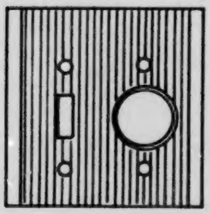


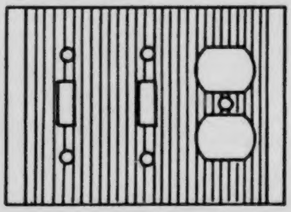




v. ______________ w. ______________ x. ______________ y. ______________

______________ ______________ ______________ ______________





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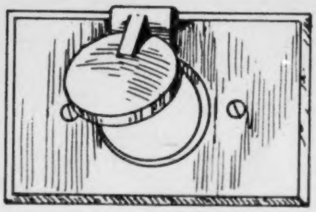
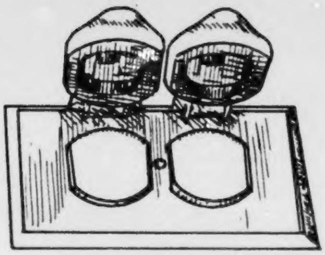
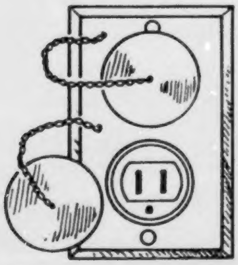
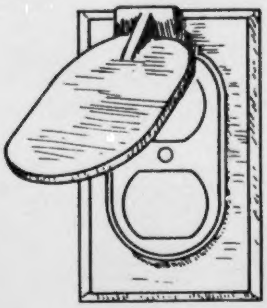


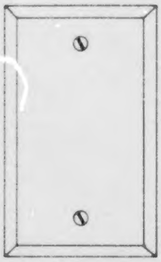


bb. ____________________

cc. ____________________



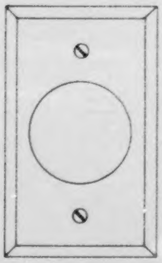


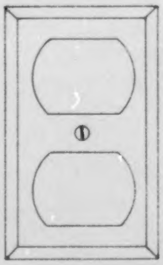


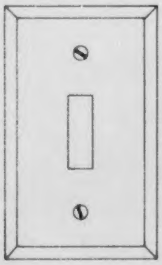
dd. ________________

ee. ________________

ff. ________________





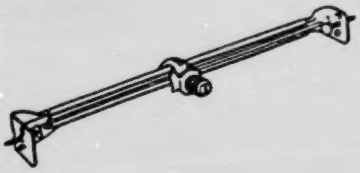


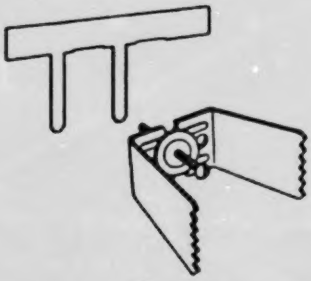
gg. ________________

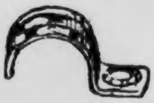
hh. ________________

ii. ________________

5. Identify the following common supports and anchors.



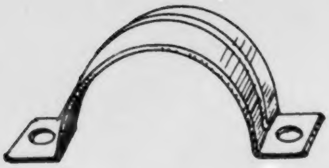




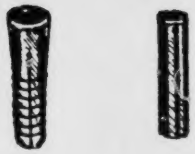
a. ________________

b. ________________

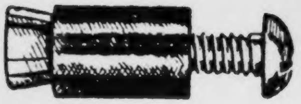
c. ________________



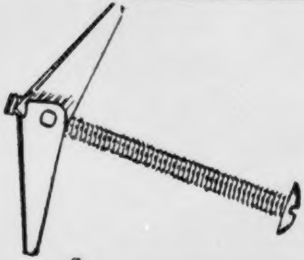
d. ________



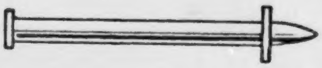
e. ________



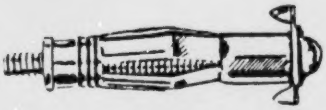
f. ________



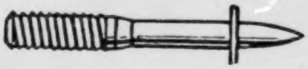
g. ________



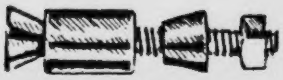
h. ________



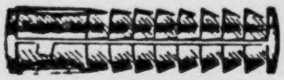
i. ________



j. ________



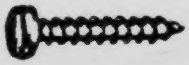
k. ________



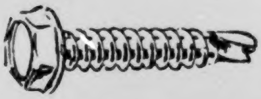
l. ________

6. Identify the following common screws, bolts, nuts, and nails.

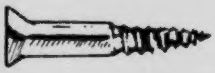
SCREWS



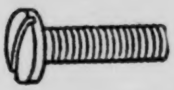
a. ________



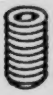
b. ________



c. ________

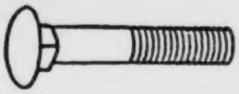


d. ________

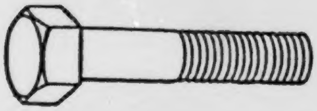


e. ________

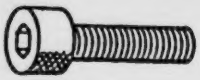
BOLTS



f. ______________

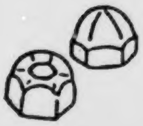


g. ______________

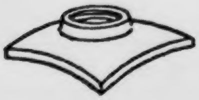


h. ______________

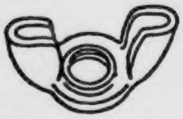
NUTS



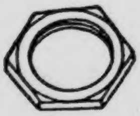
i. ______________



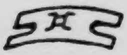
j. ______________



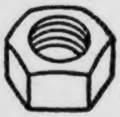
k. ______________



l. ______________

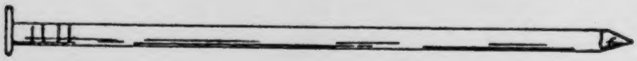


m. ______________

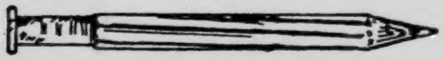


n. ______________

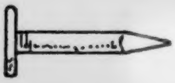
NAILS



o. ______________



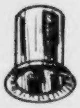
p. ______________



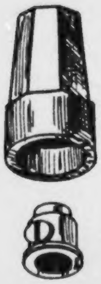
q. ______________

7. Identify the following common connectors, terminals, and lugs.

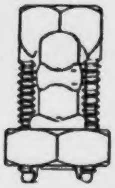
CONNECTORS



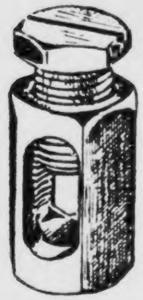
a. ____________________



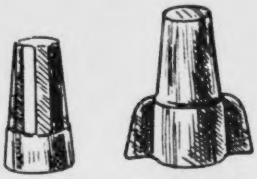
b. ____________________



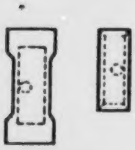
c. ____________________



d. ____________________

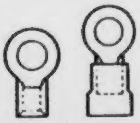


e. ____________________

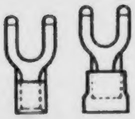


f. ____________________

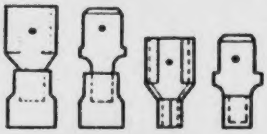
TERMINALS



g. ____________________

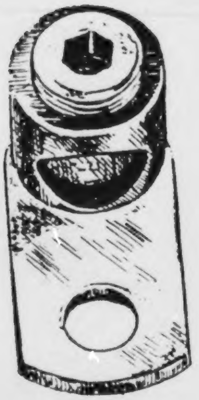


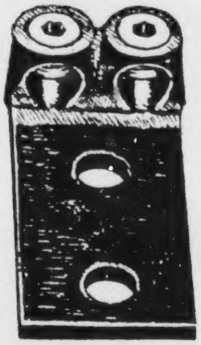
h. ____________________



i. ____________________

LUGS





j. ______________________ k. ______________________

8. List four factors to consider when selecting connectors, terminals, and lugs.

   a.

   b.

   c.

   d.

EQUIPMENT
UNIT I

ANSWERS TO TEST

1. a. Handy box (one piece molded construction)
   b. Handy box (one piece welded construction)
   c. Extension
   d. Bracket box
   e. Bracket nongangable with cable clamps
   f. Gangable with nail holes
   g. Gangable with ears and cable clamps
   h. Gangable bracket box with cable clamps
   i. With dry wall grips, cable clamps and ears
   j. Beveled corner with cable clamps
   k. Gangable with grounding pigtail
   l. Nail-on
   m. Solid two gang bracket
   n. With cable clamps and nail holes
   o. With bracket
   p. Extension
   q. With cable clamps and grounding pigtail
   r. With bar hanger and cable clamps
   s. Square box (one piece molded construction)
   t. Square box (one piece welded construction)
   u. With bracket
   v. With bracket, cable clamps, and grounding pigtail
   w. Extension

2. Any six of the following:
   a. Type of box needed
   b. Size of box needed
   c. Type of clamps (if needed)
   d. Type of bracket (if needed)
   e. Type, number, and position of openings
   f. Grounding considerations (if box is metal type)
   g. Plaster ears
3. a. Range receptacle--125/250v; 50 amp
   b. Dryer receptacle--125/250v; 30 amp
   c. Air-conditioner receptacle--250v; 20 amp
   d. Duplex grounding receptacle--125v; 15 amp
   e. Dual voltage receptacle--125/250v; 20 amp
   f. Air-conditioning receptacle--250v; 30 amp
   g. Single pole
   h. Three way
   i. Four way
   j. Double pole
   k. Dimmer
   l. Low voltage push button
   m. Switch and receptacle
   n. Two switches
   o. Switch and pilot light
   p. Keyless pigtail
   q. Keyless cover
   r. Pull chain cover
   s. Pull chain cover with grounding type receptacle

4. a. Flat blank
   b. Flat with knockout
   c. Raised with knockout
   d. Raised for single device
   e. Raised open
   f. Flat toggle
   g. Flat duplex receptacle
   h. Flat single receptacle
   i. Flat blank
   j. Flat blank with knockout
   k. Raised open
   l. Flat single device
   m. Raised single device
   n. Flat two device
   o. Raised two device
   p. Single toggle switch
   q. Single receptacle
   r. Duplex receptacle
   s. Two toggle switches
   t. Two single receptacles
   u. Toggle and duplex receptacle
   v. Single toggle
   w. Duplex receptacle
   x. Two toggle
   y. Single toggle and duplex receptacle
   z. Single toggle and single receptacle
   aa. Two toggle and duplex receptacle

bb. Weatherproof single receptacle

cc. Weatherproof duplex receptacle (horizontal)

dd. Weatherproof duplex receptacle with screw covers

ee. Weatherproof duplex receptacle (vertical)

ff. Blank

gg. Single receptacle

hh. Single toggle

ii. Duplex receptacle

5. a. Bar hanger

b. Switch box supports

c. One hole strap

d. Two hole strap

e. Plastic anchors

f. Lead anchor

g. Toggle bolt

h. Drive pin

i. Molly bolt

j. Drive stud

k. Expansion bolt

l. Lag screw shield

6. a. Sheet metal screw

b. Self drilling screw

c. Wood screw

d. Machine screw

e. Set screw

f. Carriage bolt

g. Hex head bolt

h. Hex socket head bolt
i. Acorn nut
j. Spring nut
k. Wing nut
l. Fixture nut
m. Single thread nut
n. Hex (plain) nut
o. Box or common nail
p. Masonry nail
q. Galvanized roofing nail

7. a. Crimp sleeve
   b. Set screw
   c. Split bolt
   d. Service entrance
   e. Wire nuts
   f. Crimp type butt connectors
   g. Ring terminal
   h. Spade terminal
   i. Easy disconnect terminal
   j. Single terminal lug
   k. Twin terminal lug

8. a. Job to be done
   b. Type of conductors involved
   c. Size of conductors involved
   d. Number of conductors involved

WIRING METHODS
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to match wiring methods to their definitions and applications as well as demonstrate three basic skills. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with wiring methods to the correct definitions.
2. Identify wiring methods often found in residential wiring.
3. Match wiring methods to common residential applications.
4. Demonstrate the ability to:
    a. Install a set screw conduit fitting.
    b. Install a liquid tight conduit fitting.
    c. Braid the neutral conductor of a service entrance cable.

WIRING METHODS
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and job sheets.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Have students report on articles dealing with the wiring methods.

   H. Show examples of wiring methods.

   I. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Wiring Methods

      2. TM 2--Wiring Methods (Continued)

3. TM 3--Wiring Methods (Continued)

4. TM 4--Wiring Methods (Continued)

5. TM 5--Wiring Methods (Continued)

D. Job sheets

1. Job Sheet #1--Install a Set Screw Conduit Fitting

2. Job Sheet #2--Install a Liquid Tight Conduit Fitting

3. Job Sheet #3--Braid the Neutral Conductor of a Service Entrance Cable

E. Test

F. Answers to test

II. References:

A. *National Electrical Code,* 1981. Boston: National Fire Protection Association, 1980.

B. Merrick, Clyde. *Residential Electrical Wiring.* Santa Monica, California: Goodyear Publishing Company. 1976.

WIRING METHODS
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Premises wiring (system)--That interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all of its associated hardware, fittings, and wiring devices, both permanently and temporarily installed which extends from the load end of the service drop, or load end of the service lateral conductors to the outlet(s). Such wiring does not include wiring internal to appliances, fixtures, motors, controllers, motor control centers, and similar equipment

B. Raceway--An enclosed channel designed expressly for holding wires, cables, or busbars, with additional functions as permitted in the NEC

(NOTE: Raceways may be of metal or insulating material, and the term includes rigid metal conduit, rigid nonmetallic conduit, electrical metallic tubing, underfloor raceways, cellular concrete floor raceways, cellular metal floor raceways, surface raceways, wireways, and busways.)

C. Fitting--An accessory such as a locknut, busing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function

D. Equipment--A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as a part of, or in connection with, an electrical installation

E. Exposed (as applied to wiring methods)--On or attached to the surface or behind panels designed to allow access

F. Cable--A factory assembly of two or more insulated and uninsulated conductors having an outer sheath of moisture-resistant, flame-retardent, nonmetallic material

G. Concealed knob-and-tube wiring--A wiring method using knobs, tubes, and flexible nonmetallic tubing for the protection and support of single insulated conductors concealed in hollow spaces of walls and ceilings of buildings

H. Rigid metal conduit--Heavy wall metal raceway of circular cross section with integral or associated couplings, connectors and fittings approved for the installation of electrical conductors

INFORMATION SHEET

- I. Electrical metallic tubing--Thin wall metal raceway of circular cross section with integral or associated couplings, connectors and fittings approved for the installation of electrical conductors
- J. Flexible metal conduit--Spiral metal raceway designed for flexible installation with a circular cross section and integral or associated couplings, connectors and fittings approved for the installation of electrical conductors
- K. Liquid tight flexible metal conduit--Flexible metal conduit with an outer liquid tight, nonmetallic, sunlight-resistant jacket
- L. Surface raceways--Raceways designed for surface installations; constructed so as to be readily distinguishable from other raceways
- M. Low voltage (residential remote control and signal circuits)--Wiring of less than 50 volts originating at a transformer

II. Wiring methods often found in residential wiring

- A. Nonmetallic sheathed cable (Romex) (Transparency 1)
- B. Concealed knob-and-tube wiring (Transparency 1)

  (NOTE: This system was used before cables were suitably developed for efficient residential use.)
- C. Rigid metal conduit (Transparency 2)
- D. Electrical metallic tubing (EMT) (Transparency 2)
- E. Flexible metal conduit (Transparency 3)
- F. Liquid tight flexible metal conduit (Transparency 3)
- G. Surface raceways (Transparency 4)
- H. Low voltage (Transparency 4)
- I. PVC (polyvinyl chloride) (Transparency 5)

III. Wiring methods and common residential applications

- A. Cable
  - 1. Nonmetallic sheathed cable
    - a. General residential rough-in
    - b. Circuit extensions in existing dwellings

      (NOTE: Nearly all the premises wiring in most new residential homes is done with NM cable.)

INFORMATION SHEET

  2. Underground feeder and branch circuit cable (UF)--Direct burial for yard lights or extensions

B. Concealed knob-and-tube wiring

  1. Extensions of existing installations

  2. Elsewhere by special permission

C. Rigid metal conduit

  1. Through eave service masts

  2. Underground circuit extension

  3. In concrete walls, floors, or ceilings

(NOTE: Wiring in poured basement walls, ceilings and floors is usually done with rigid metal conduit.)

  4. Underground service riser

D. Electrical metallic tubing

  1. Service raceway

     (NOTE: EMT is not suitable for installations going through an eave.)

  2. Protecting grounding electrode conductor

E. Flexible metal conduit

  1. Connecting recessed lighting fixtures

  2. Enclosing motor leads

F. Liquid tight flexible metal conduit

  1. Connecting air conditioning condensers to disconnects

  2. Enclosing motor leads needing protection from liquids and vapors

G. Surface raceways

  1. Interior circuit extensions where concealed work is not necessary or not possible

  2. On interior concrete surfaces

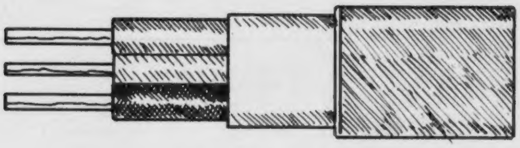
INFORMATION SHEET

H. Low voltage

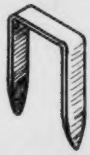
1. Chime circuits
2. Intercom wiring
3. Thermostat circuits
4. Lighting control

WIRING METHODS

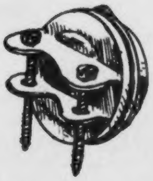
NONMETALLIC SHEATHED CABLE



NM CABLE

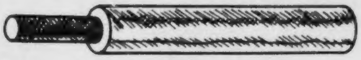


STAPLE

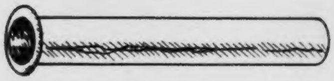


CONNECTOR

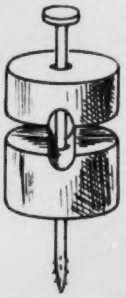
CONCEALED KNOB AND TUBE



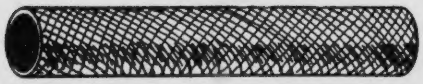
INSULATED CONDUCTOR



PORCELAIN TUBE



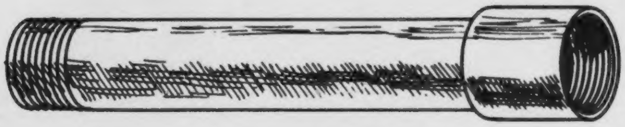
KNOB



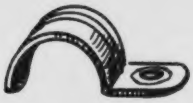
BRAIDED LOOM

WIRING METHODS (continued)

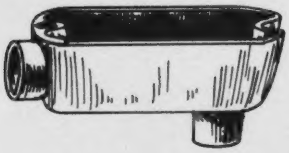
RIGID METAL CONDUIT



METAL CONDUIT AND COUPLING

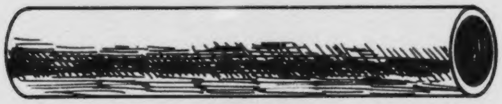


ONE-HOLE STRAP

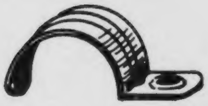


CONDUIT BODY

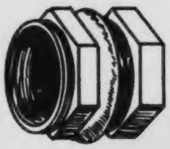
ELECTRICAL METALLIC CONDUIT



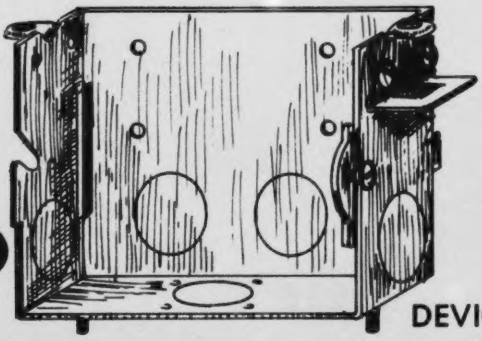
ELECTRICAL METALLIC CONDUIT



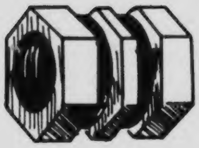
ONE-HOLE STRAP



EMT CONNECTOR



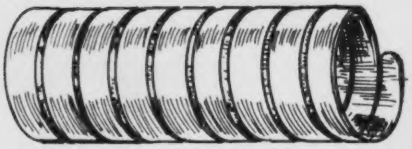
DEVICE BOX FOR CONDUIT



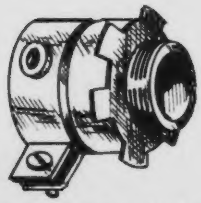
EMT COUPLING

WIRING METHODS (continued)

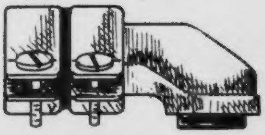
FLEXIBLE METAL CONDUIT



FLEXIBLE METAL CONDUIT

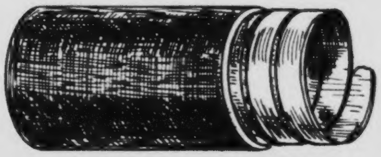


STRAIGHT CONNECTOR



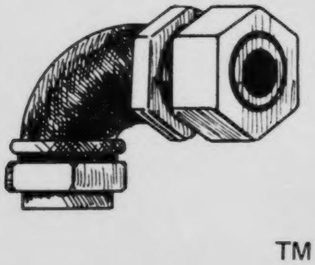
90° CONNECTOR

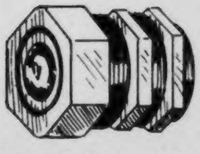
LIQUID TIGHT FLEXIBLE METAL CONDUIT



LIQUID TIGHT FLEXIBLE METAL CONDUIT

90° LIQUID TIGHT CONNECTOR

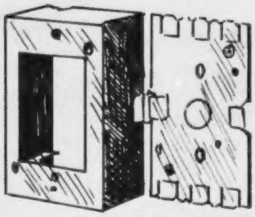




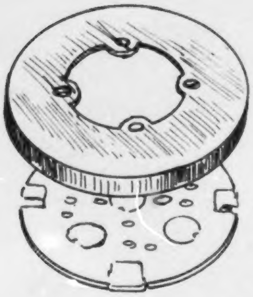
LIQUID TIGHT CONNECTOR

WIRING METHODS (continued)

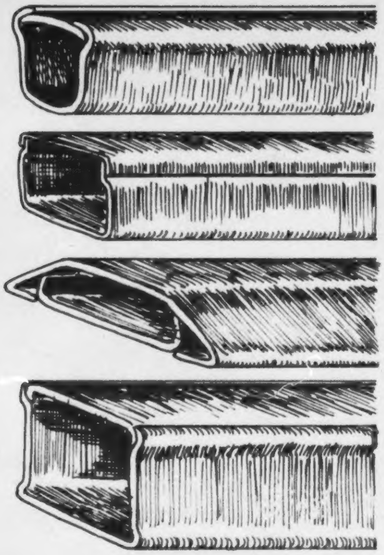
SURFACE RACEWAYS



SURFACE DEVICE BOX



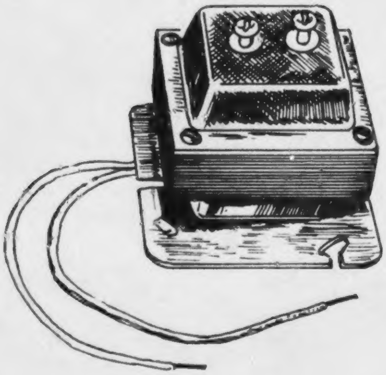
SURFACE LIGHTING OUTLET

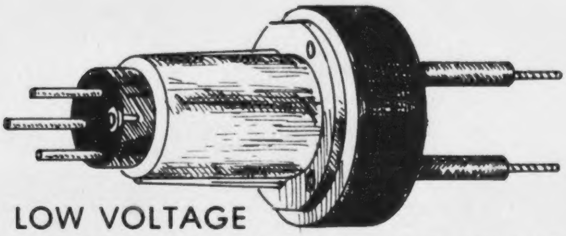


SURFACE RACEWAYS

LOW VOLTAGE

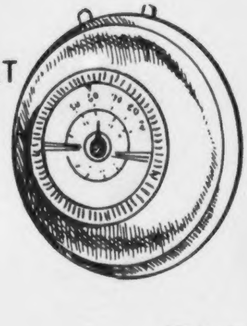
TRANSFORMER

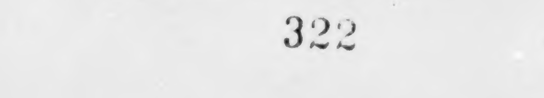




LOW VOLTAGE
CONTROLLED LIGHTING RELAY

THERMOSTAT

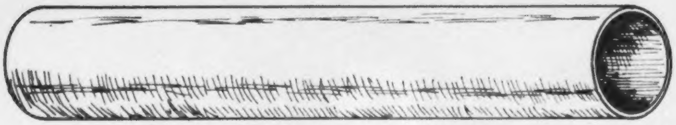


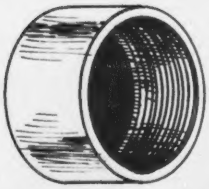


LOW VOLTAGE CABLE

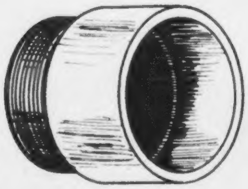
WIRING METHODS (continued)

PVC (POLYVINYL CHLORIDE)



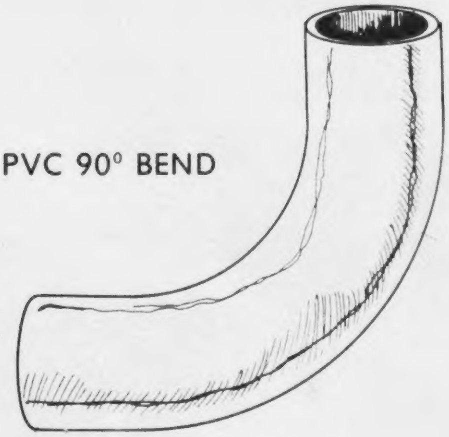


PVC TO THREADED ADAPTER
(FEMALE)



PVC TO THREADED ADAPTER
(MALE)

PVC 90° BEND



WIRING METHODS
UNIT II

JOB SHEET #1--INSTALL A SET SCREW CONDUIT FITTING

I. Tools and equipment

   A. 1/2" set screw fitting

   (NOTE: For this job sheet either a connector or coupling is suitable.)

   B. 1/2" conduit

   C. Screwdriver

   D. Safety glasses

II. Procedure

   (NOTE: Conduit should be reamed and should have a square cut end.)

   A. Put on safety glasses

   B. Gather tools and equipment

   C. Pick up the connector

   (NOTE: Hold it in the most skillful of your hands. Right-handed person should hold in right hand.)

   D. Pick up the conduit with other hand

   E. Slide the connector onto the conduit till it bottoms (Figure 1)

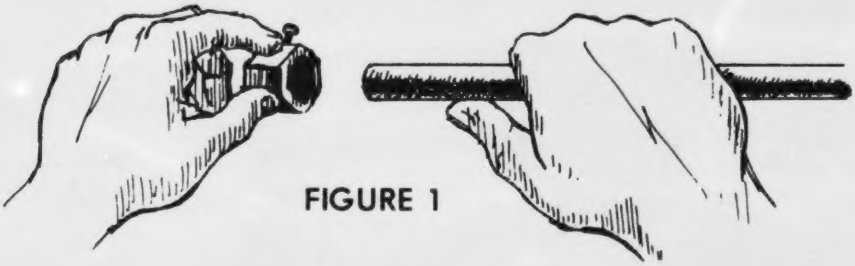


FIGURE 1

JOB SHEET #1

F. Secure screw with screwdriver (Figure 2)

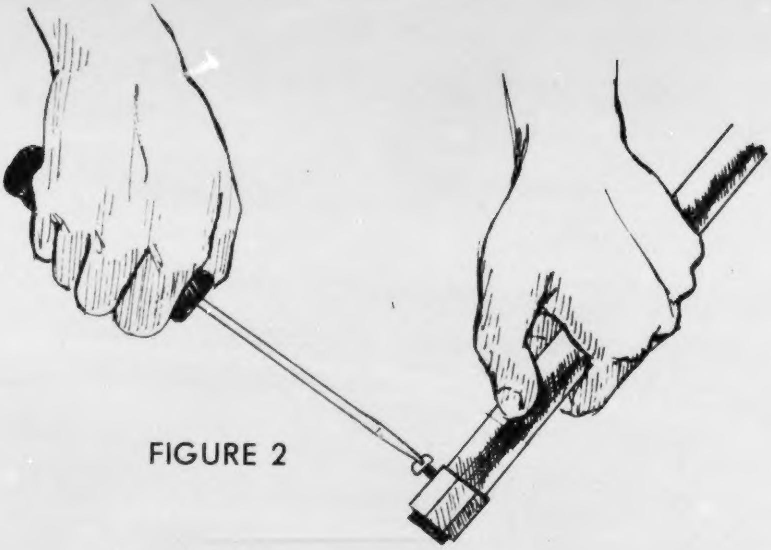


FIGURE 2

(CAUTION: Keep hand holding conduit in position away from the connector to avoid getting jabbed if the screwdriver should slip. Don't overtighten set screw.)

(NOTE: During this operation the least skillful of your hands should be involved only in the holding of the conduit after step D. This nonshifting approach should save time by saving hand movement.)

WIRING METHODS
UNIT II

JOB SHEET #2--INSTALL A LIQUID TIGHT CONDUIT FITTING

I. Tools and equipment

  A. 1/2" compression type fitting

  (NOTE: For the purpose of this job sheet either a connector or coupling may be used.)

  B. 1/2" conduit

  C. 2 pairs groove joint pliers

  (NOTE: Two adjustable wrenches or one wrench and one pair of pliers will also suffice.)

  D. Safety glasses

II. Procedure

  (NOTE: The conduit should be reamed and should have straight even ends.)

  A. Put on safety glasses

  B. Gather tools and equipment

  C. Pick up connector

  (NOTE: Hold in least skillful hand and use most skillful for next two operations to avoid handshifting.)

  D. Loosen compression nut

  (NOTE: Don't completely remove nut. Look inside and be sure compression ring is inside the fitting. See Figure 1.)

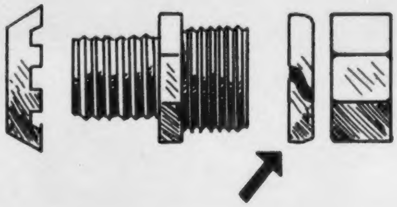


FIGURE 1

JOB SHEET #2

E. Slide fitting onto conduit (Figure 2)

(NOTE: The conduit should make a click that will also be felt when it bottoms.)

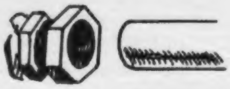


FIGURE 2

F. Tighten compression nut by hand (Figure 3)

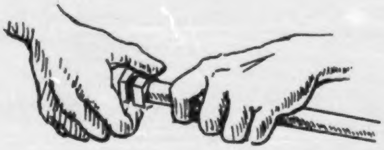


FIGURE 3

G. Tighten fitting with pliers or adjustable wrenches (Figure 4)

(CAUTION: Overtightening the smaller trade size fittings can cause threads to strip or nuts to crack.)

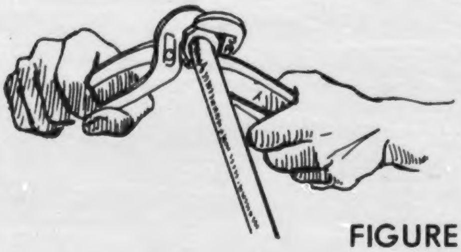


FIGURE 4

WIRING METHODS
UNIT II

JOB SHEET #3--BRAID THE NEUTRAL CONDUCTOR OF A SERVICE ENTRANCE CABLE

I. Tools and equipment

   A. SE cable

   B. Knife

   C. Safety glasses

   D. Lineman's pliers

II. Procedure

   A. Put on safety glasses

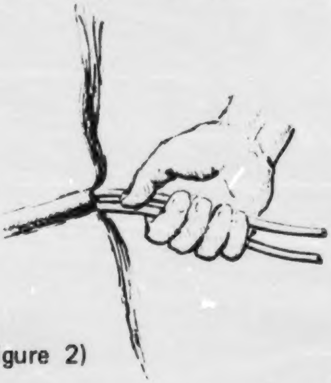
   B. Gather tools and equipment

   C. Strip off a length of the outer sheath

   (NOTE: Always use safe working practices when using a knife.)

   D. Separate the neutral strands into two separate groups (Figure 1)

FIGURE 1



   E. Stand on the cable (Figure 2)

   (NOTE: Be sure the conductors are not on rocks or other materials that could damage the insulation while you have them secured.)

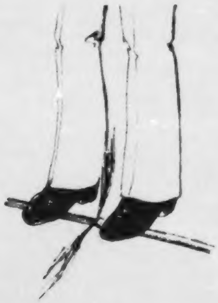


FIGURE 2

JOB SHEET #3

F. Bend over and grasp the separated neutral (Figure 3)

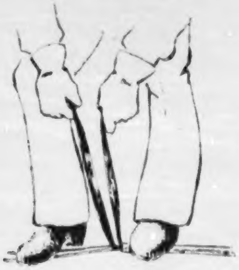


FIGURE 3

G. Twist the conductor together while pulling upward (Figure 4)

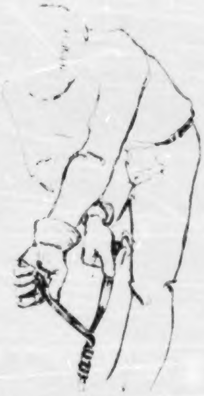


FIGURE 4

H. Braid as far as possible by hand (Figure 5)

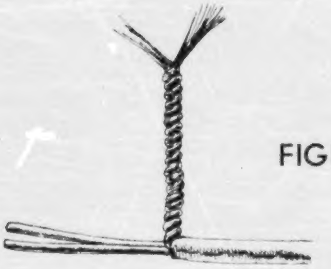


FIGURE 5

JOB SHEET #3

I. Twist with pliers until braid is continuous and uniform (Figure 6)

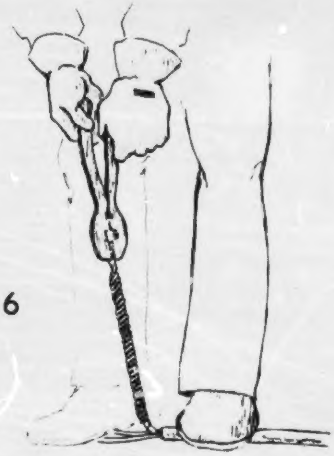


FIGURE 6

J. Have instructor evaluate work

WIRING METHODS
UNIT II

NAME ______________________________

TEST

1. Match terms on the right to the correct definitions.

_____a. That interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all of its associated hardware, fittings, both permanently and temporarily installed which extends from the load end of the service drop, or load end of the service lateral conductors to the outlet(s). Such wiring does not include wiring internal to appliances, fixtures, motors, controllers, motor control centers, and similar equipment

_____b. An enclosed channel designed expressly for holding wires, cables, or busbars, with additional functions as permitted in the NEC

_____c. An accessory such as a locknut, bushing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function

_____d. A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as a part of, or in connection with, an electrical installation

_____e. On or attached to the surface or behind panels designed to allow access

_____f. A factory assembly to two or more insulated conductors having an outer sheath of moisture-resistant, flame-retardant, non-metallic material

1. Exposed (as applied to wiring methods)
2. Electrical metallic tubing
3. Liquid tight flexible metal conduit
4. Low voltage (residential remote control and signal circuits
5. Premises wiring (system)
6. Equipment
7. Surface raceways
8. Flexible metal conduit
9. Raceway
10. Concealed knob-and-tube wiring
11. Fitting
12. Cable
13. Rigid metal conduit

______ g. A wiring method using knobs, tubes, and flexible nonmetallic tubing for the protection and support of single insulated conductors concealed in hollow spaces of walls and ceilings of buildings

______ h. Heavy wall metal raceway of circular cross section with integral or associated couplings, connectors and fittings approved for the installation of electrical conductors

______ i. Thin wall metal raceway of circular cross section with integral or associated couplings, connectors and fittings approved for the installation of electrical conductors

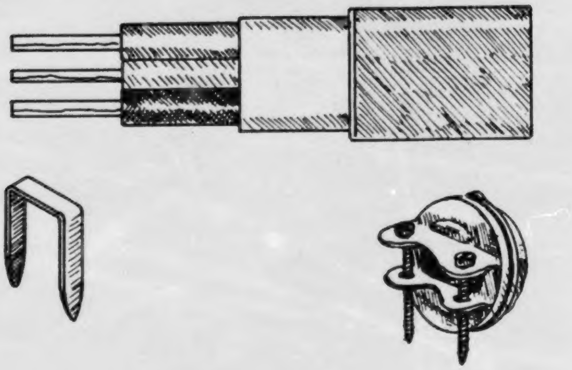
______ j. Spiral metal raceway designed for flexible installation with a circular cross section and integral or associated couplings, connectors and fittings approved for the installation of electrical conductors

______ k. Flexible metal conduit with an outer liquid tight, nonmetallic, sunlight-resistant jacket

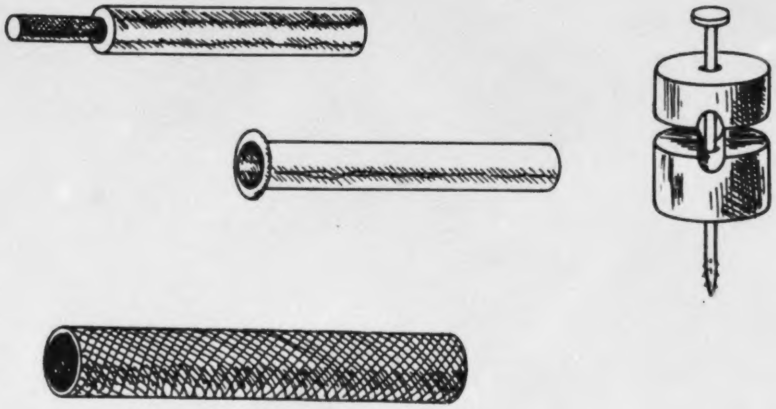
______ l. Raceways designed for surface installations; constructed so as to be readily distinguishable from other raceways

______ m. Wiring of less than 50 volts originating at a transformer

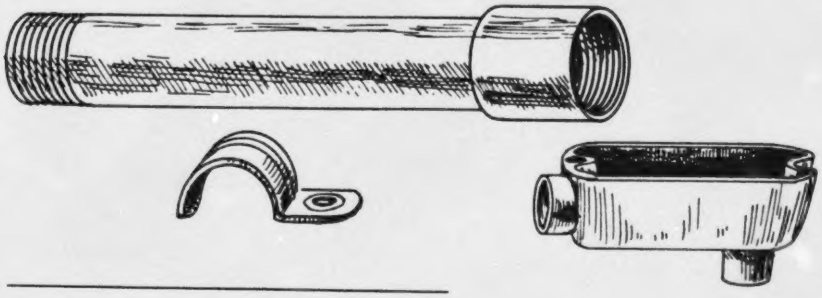
2. Identify wiring methods often found in residential wiring.



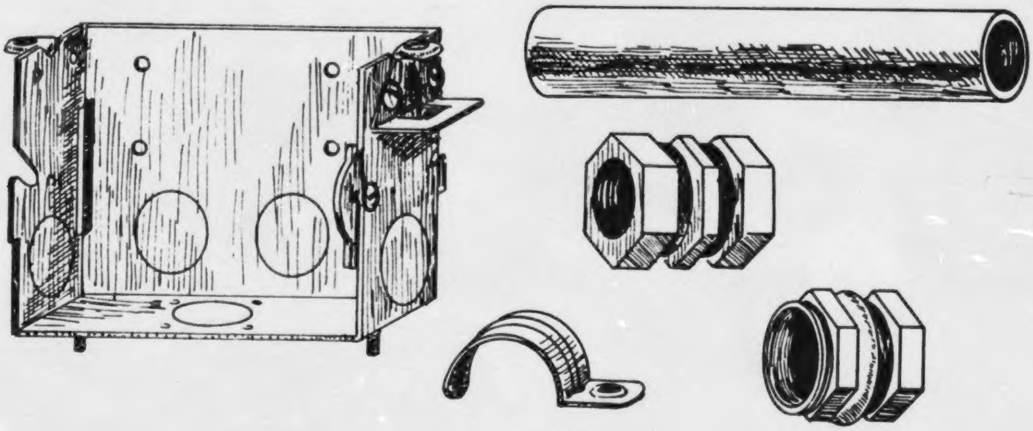
a. ______________________________



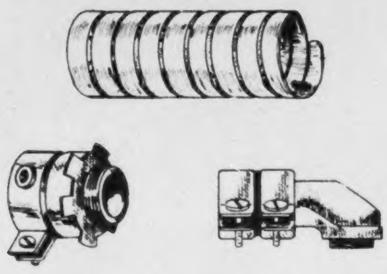
b. ______________________________



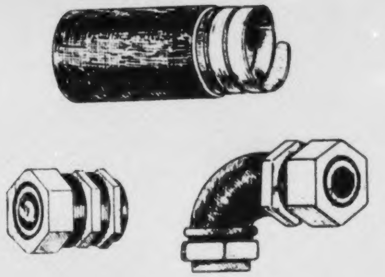
c. ______________________________



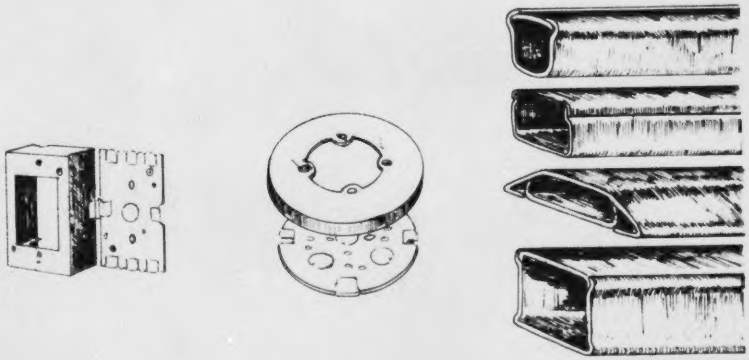
d. ______________________________



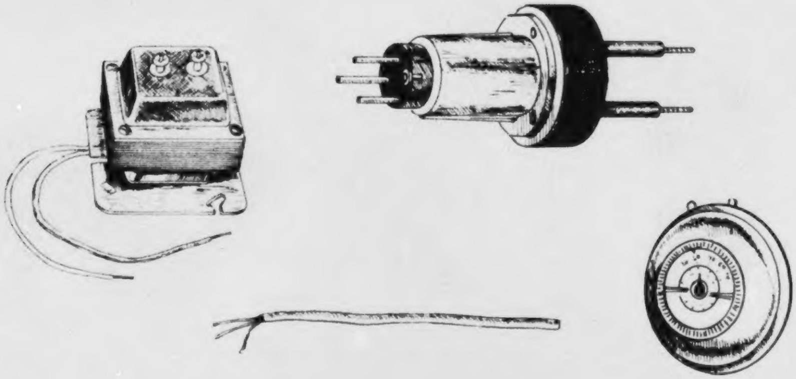
e. ____________________



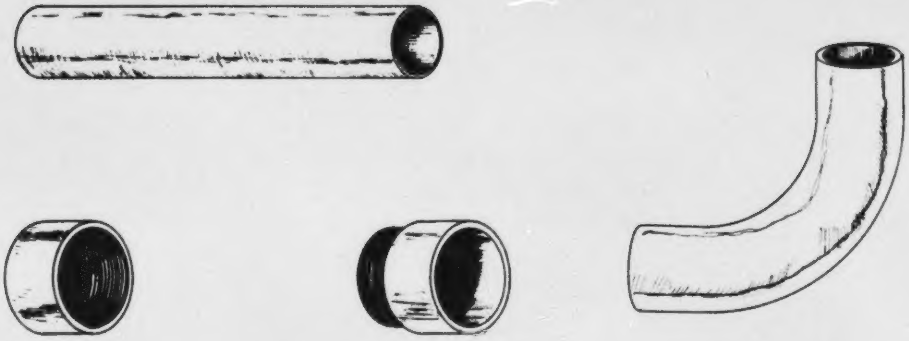
f. ____________________



g. ____________________



h. ____________________



i. ______________________

3. Match the wiring methods on the right to common residential applications.

_____a. 1) Nonmetallic sheathed cable
  a) General residential rough-in
  b) Circuit extensions in existing dwellings
 2) Underground feeder and branch circuit cable (UF)--Direct burial for yard lights or extensions

_____b. 1) Extensions of existing installations
 2) Elsewhere by special permission

_____c. 1) Through eave service masts
 2) Underground circuit extension
 3) In concrete wall, floors, or ceilings
 4) Underground service riser

_____d. 1) Service raceway
 2) Protecting grounding electrode conductor

1. Liquid tight flexible metal conduit
2. Electrical metallic tubing
3. Cable
4. Low voltage
5. Concealed knob-and-tube wiring
6. Rigid metal conduit
7. Surface raceways
8. Flexible metal conduit

_____e. 1) Connecting recessed lighting fixtures
  2) Enclosing motor leads

_____f. 1) Connecting air conditioning condensers to disconnects
  2) Enclosing motor leads needing protection from liquids and vapors

_____g. 1) Interior circuit extensions where concealed work is not necessary or not possible
  2) On interior concrete surfaces

_____h. 1) Chime circuits
  2) Intercom wiring
  3) Thermostat circuits
  4) Lighting control

4. Demonstrate the ability to:

a. Install a set screw conduit fitting.

b. Install a liquid tight conduit fitting.

c. Braid the neutral conductor of a service entrance cable.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

WIRING METHODS
UNIT II

ANSWERS TO TEST

1. a. 5
   b. 9
   c. 11
   d. 6
   e. 1
   f. 12
   g. 10
   h. 13
   i. 2
   j. 8
   k. 3
   l. 7
   m. 4

2. a. Nonmetallic sheathed cable (Romex)
   b. Concealed knob-and-tube wiring
   c. Rigid metal conduit
   d. Electrical metallic tubing (EMT)
   e. Flexible metal conduit
   f. Liquid tight flexible metal conduit
   g. Surface raceways
   h. Low voltage
   i. PVC (polyvinyl chloride)

3. a. 3
   b. 5
   c. 6
   d. 2
   e. 8
   f. 1
   g. 7
   h. 4

4. Performance skills evaluated to the satisfaction of the instructor

LOAD CENTERS
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify parts and components as well as list facts about load centers. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with load centers to the correct definitions.
2. Identify two types of safety switch enclosures.
3. Identify common load center accessories.
4. List three possible installations for load centers.
5. Identify the parts of a fusible load center.
6. Identify the parts of a breaker load center.
7. List five safety rules for working around load centers and safety switches.
8. Identify common panel interior configurations.

LOAD CENTERS
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information sheet.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheets.

   F. Show students examples of various types of load centers.

   G. Examine load centers in your shop and school.

   H. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Study types of load centers used in instructor examples.

   D. Examine load centers in the shop and school.

   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Safety Switch Enclosures

      2. TM 2--Load Center Accessories

      3. TM 3--Load Center Installations

    4. TM 4--Parts of a Fusible Load Center
    5. TM 5--Parts of a Breaker Load Center
    6. TM 6--Common Bus Configurations

  D. Test

  E. Answers to test

II. References:

  A. *Speedfax*. I-T-E Imperial Corporation, 1971.

  B. *Selection Guide*. Milwaukee, Wisconsin: Cutler-Hammer/Power Distribution and Control Division.

  C. *Digest*. Park Ridge, Illinois: Square D Company, 1972.

LOAD CENTERS
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. NEMA (National Electrical Manufacturer's Association)--Organization responsible for the setting of specifications for the various classes of enclosures

B. NEMA Type 1--General purpose enclosure for use indoors under usual service conditions

C. NEMA Type 2--Driptight enclosure used indoors to exclude falling moisture and dirt

D. NEMA Type 3--Weather resistant (weatherproof) and suitable for indoor and outdoor use; will exclude falling dirt, light liquid splashing, rain, snow, sleet, and windblown dust

(NOTE: Descriptors placed after the code number specify the suitable applications. A NEMA Type 3R is a common residential outdoor enclosure. The R stands for raintight and signifies that the enclosure will not exclude windblown dust.)

E. NEMA Type 4--Watertight and dustproof enclosures suitable for areas where a great amount of splashing occurs, such as hose down area

F. NEMA Type 5--Dust-tight enclosure not suitable for use around water

(NOTE: All NEMA Type 12 enclosures and JIC (Joint Industry Conference) enclosures are suitable for NEMA Type 5 applications.)

G. NEMA Type 12--Industrial use enclosure designed to exclude oil, coolant, flying dust and lint, and falling dirt

H. Cabinet--An enclosure designed either for surface or flush mounting and provided with a frame, mat, or trim in which a swinging door or doors are or may be hung

I. Disconnecting means--A device or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply

J. Dustproof--So constructed or protected that dust will not interfere with its successful operation

K. Dust-tight--So constructed that dust will not enter the enclosing case

INFORMATION SHEET

   L. Rainproof--So constructed, protected, or treated as to prevent rain from interfering with successful operation of the apparatus

   M. Raintight--So constructed or protected that exposure to a beating rain will not result in the entrance of water

II. Safety switch enclosures (Transparency 1)

(NOTE: This can be either a general duty or H.P. rated switch.)

   A. Indoor (NEMA Type 1)

   B. Raintight (NEMA Type 3R)

   (NOTE: These switches can be fusible or nonfusible, depending on need. Either type will serve as the disconnect for a residential air conditioning system condenser.)

III. Common load center accessories (Transparency 2)

   A. Grounding or grounded bar

   (NOTE: As an accessory this component can be installed as an equipment grounding bar or additional neutral space.)

   B. Flush lock

   C. Closure plate

   D. Conduit hubs for rainproof enclosures

   E. Lug

   F. Padlock attachment

   G. Lock off (for breakers)

   H. Handle tie

   (NOTE: The tie is used to cause simultaneous mechanical tripping between two breakers.)

IV. Installations for load centers (Transparency 3)

(NOTE: These are all possible places for the installation of service equipment for both new construction and remodel work. A new exterior mounted panel is often used to feed an existing panel as a sub-panel to get more circuits in a remodel.)

   A. Flush (interior)

INFORMATION SHEET

- B. Surface (interior)

  (NOTE: The only difference in the equipment used for the interior installations is the panel cover.)

- C. Exterior (Surface)

  (NOTE: These enclosures are usually NEMA Type 3R breaker assemblies.)

V. Parts of a fusible load center (Transparency 4)

- A. Grounded bar (neutral)
- B. Grounding bar
- C. Main fuse pullout
- D. Line lugs
- E. Plug fuse socket
- F. Pullouts

VI. Parts of a breaker load center

- A. Main breaker line lugs
- B. Grounded bar (neutral)
- C. Main breaker
- D. Grounding bar
- E. Bus bars
- F. Pole spaces

VII. Safety rules for working around load centers and safety switches

- A. Don't tamper with or alter equipment
- B. Install for intended purpose
- C. Install according to NEC
- D. Don't hold extra tools in your hand during installation or maintenance
- E. Stand to the side of a disconnect before energizing it

INFORMATION SHEET

VIII. Common panel interior configurations (Transparency 6)

A. Main breaker--Single phase

(NOTE: This is the most commonly installed panel in single family dwellings.)

B. No main--Single phase

C. Split bus--Single phase

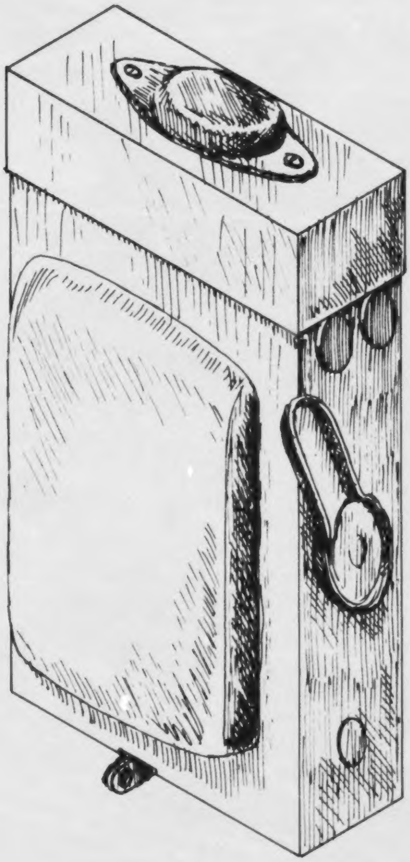
(NOTE: The lighting main comes from the double pole spaces at the top. This can save money over a large main breaker panel.)

D. Double split bus--Single phase

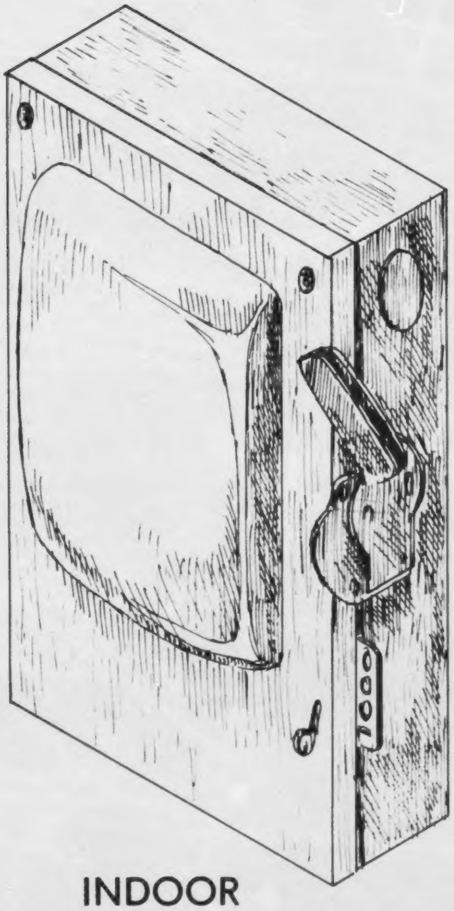
E. No main--Three phase

(NOTE: Three phase panels with and without main breakers are not commonly used in residential applications.)

SAFETY SWITCH ENCLOSURES

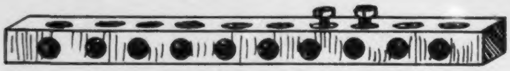


RAINTIGHT

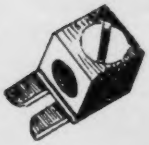


INDOOR

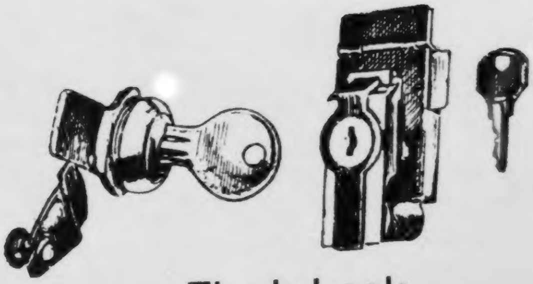
LOAD CENTER ACCESSORIES



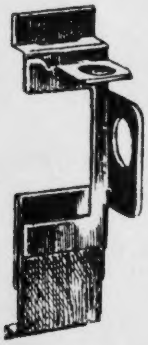
Grounding or Grounded Bars



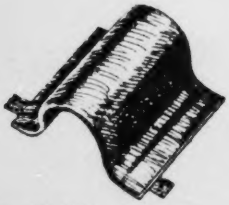
Lug



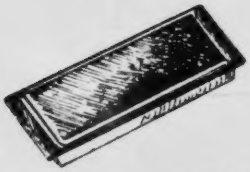
Flush Lock



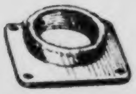
Padlock Attachment



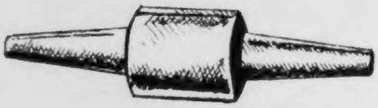
Lock Off



Closure Plate



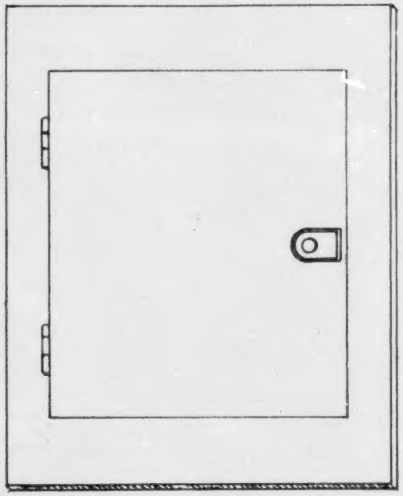
Conduit Hubs for
Rainproof Enclosure



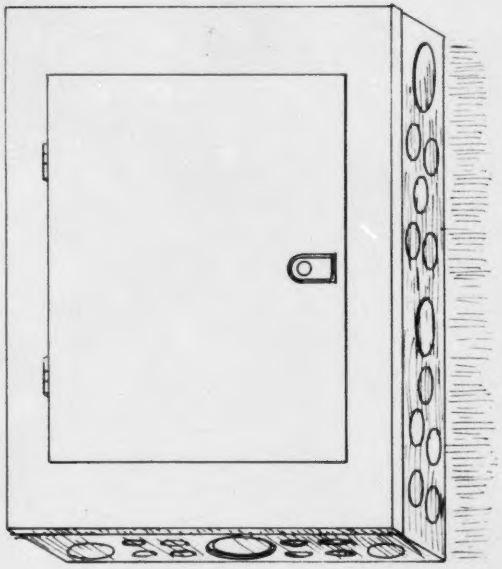
Handle Tie

LOAD CENTER INSTALLATIONS

INTERIOR

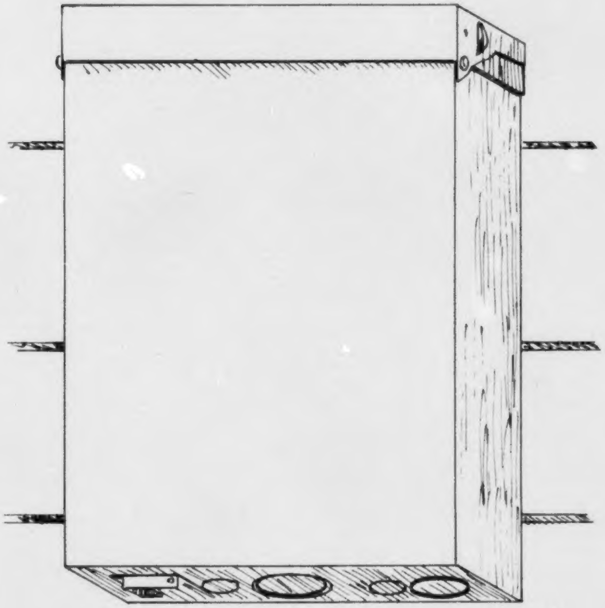


Flush

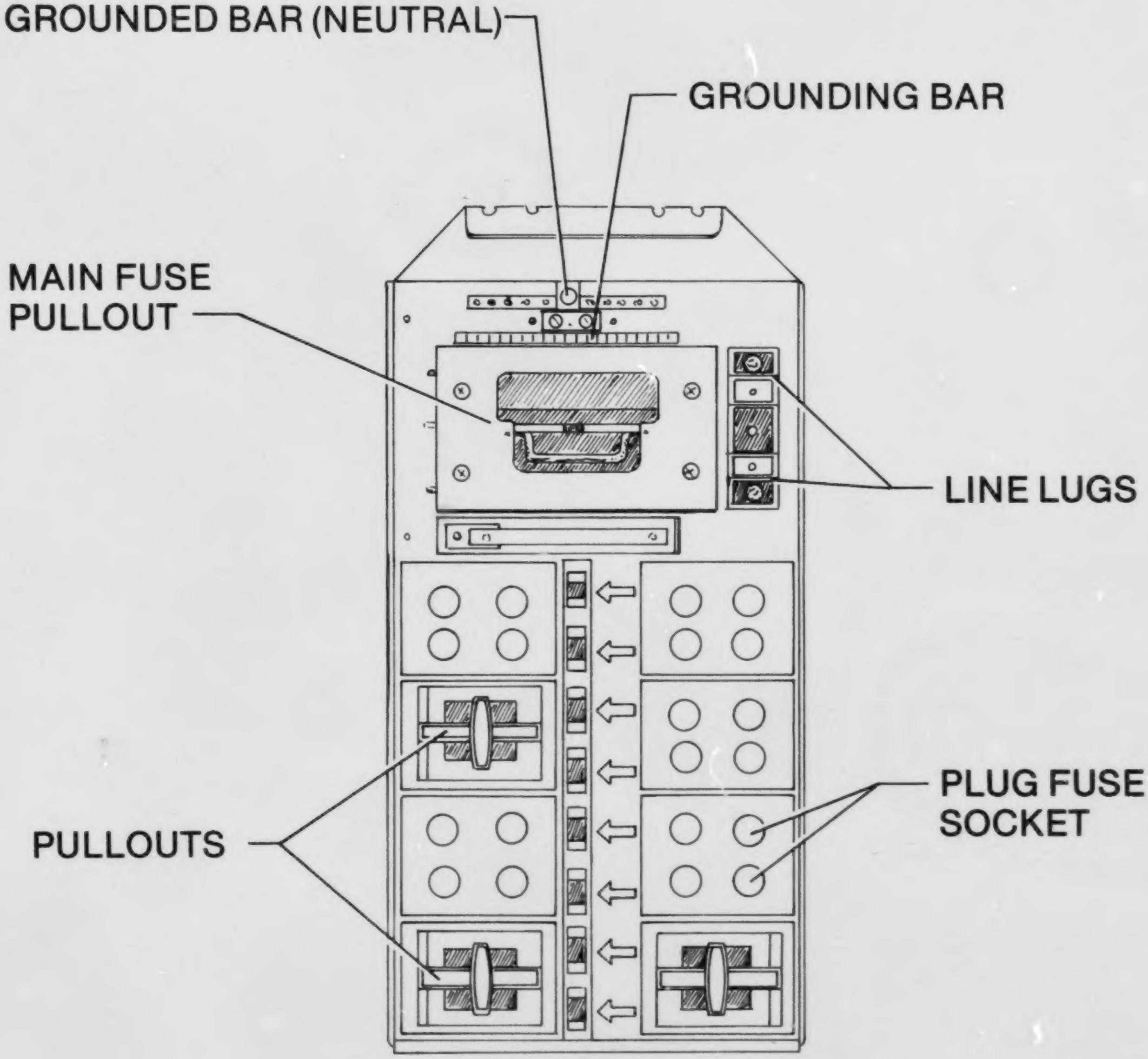


Surface

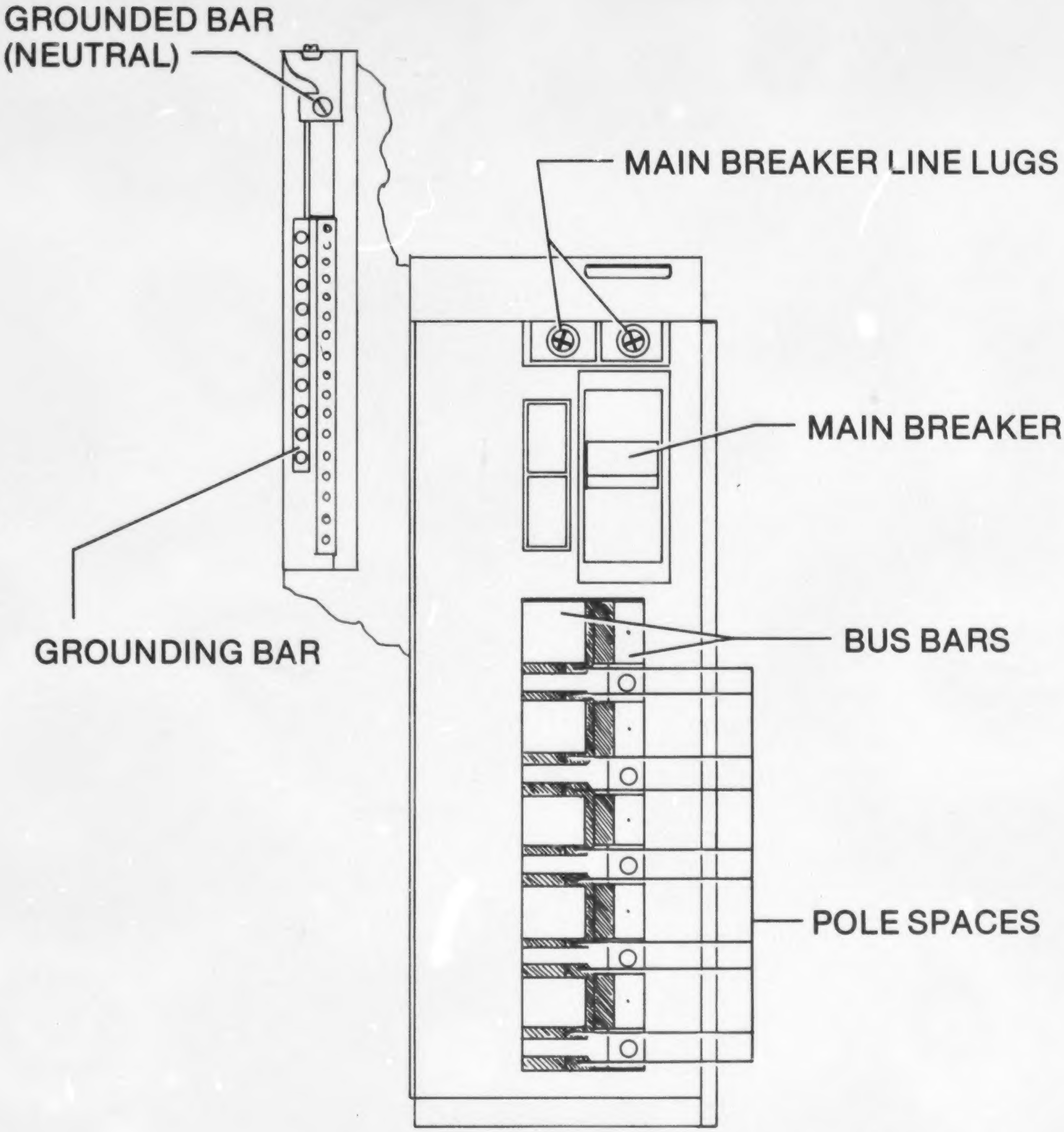
EXTERIOR SURFACE



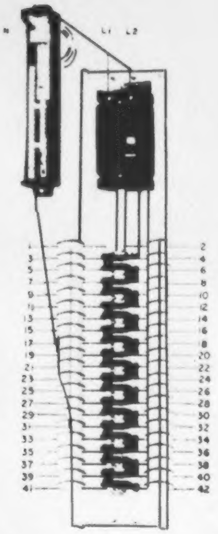
PARTS OF A FUSIBLE LOAD CENTER


GROUNDED BAR (NEUTRAL)
GROUNDING BAR
MAIN FUSE PULLOUT
LINE LUGS
PLUG FUSE SOCKET
PULLOUTS

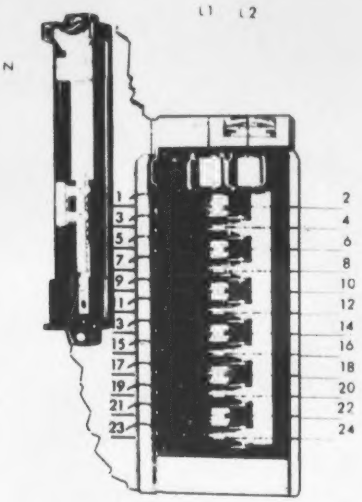
PARTS OF A BREAKER LOAD CENTER


GROUNDED BAR
(NEUTRAL)
MAIN BREAKER LINE LUGS
MAIN BREAKER
BUS BARS
POLE SPACES
GROUNDING BAR

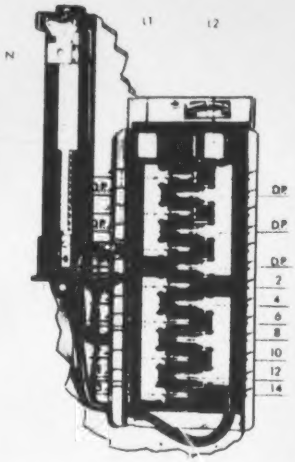
COMMON BUS CONFIGURATIONS


N
L1
L2
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42

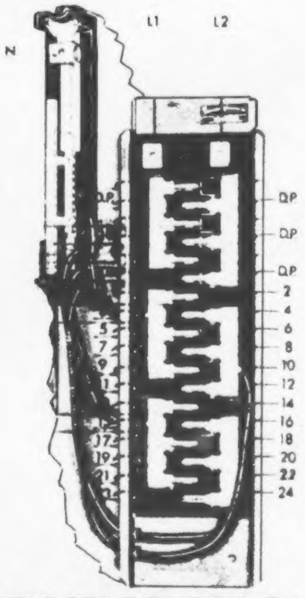
MAIN BREAKER SINGLE PHASE


N
L1
L2
1 3 5 7 9 11 13 15 17 19 21 23
2 4 6 8 10 12 14 16 18 20 22 24

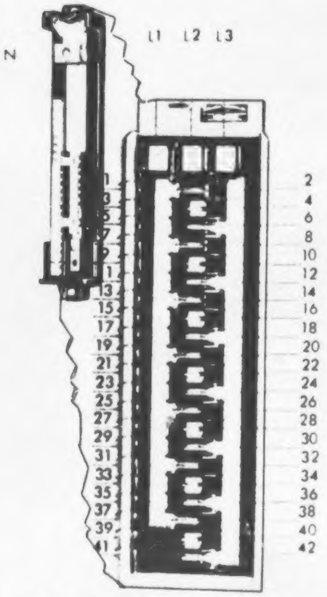
NO-MAIN SINGLE PHASE


N
L1
L2
D.P.
D.P.
D.P.
2 4 6 8 10 12 14

SPLIT BUS SINGLE PHASE


N
L1
L2
D.P.
D.P.
D.P.
2 4 6 8 10 12 14 16 18 20 22 24
5 7 9 17 19 21

DOUBLE SPLIT BUS SINGLE PHASE


N
L1
L2
L3
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42

THREE PHASE NO-MAIN

LOAD CENTERS
UNIT III

NAME ____________________

TEST

1. Match terms associated with load centers to the correct definitions.

______a. Organization responsible for the setting of specifications for the various classes of enclosures

______b. General purpose enclosure for use indoors under usual service conditions

______c. Driptight enclosure used indoors to exclude falling moisture and dirt

______d. Weather resistant (weatherproof) and suitable for indoor or outdoor use; will exclude falling dirt, light liquid splashing, rain, snow, sleet, and windblown dust

______e. Watertight and dustproof enclosures suitable for areas where a great amount of splashing occurs, such as hose down areas

______f. Dust-tight enclosure not suitable for use around water

______g. Industrial use enclosure designed to exclude oil, coolant, flying dust and lint, and falling dirt

______h. An enclosure designed either for surface or flush mounting and provided with a frame, mat, or trim in which a swinging door or doors are or may be hung

______i. A device or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply

______j. So constructed or protected that dust will not interfere with its successful operation

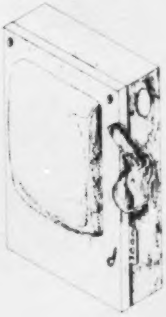
1. NEMA (Type 4)
2. NEMA (National Electrical Manufacturer's Association)
3. NEMA Type 12
4. Dust-tight
5. Cabinet
6. NEMA Type 3
7. Disconnecting means
8. NEMA Type 2
9. Raintight
10. Rainproof
11. Dustproof
12. NEMA Type 5
13. NEMA Type 1

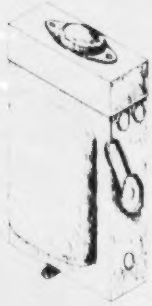
_____k. So constructed that dust will not enter the enclosing case

_____l. So constructed, protected, or treated as to prevent rain from interfering with successful operation of the apparatus

_____m. So constructed or protected that exposure to a beating rain will not result in the entrance of water

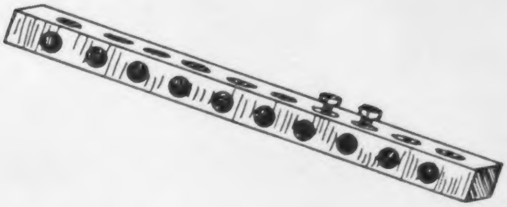
2. Identify two types of safety switch enclosures.

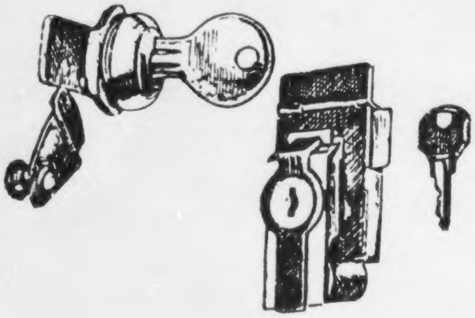




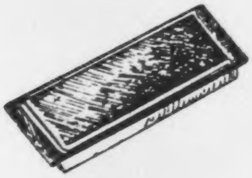
a. ______________________________ b. ______________________________

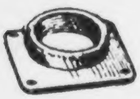
3. Identify common load center accessories.



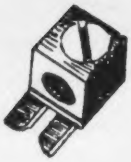


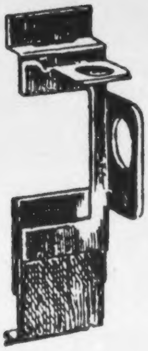
a. ______________________________ b. ______________________________



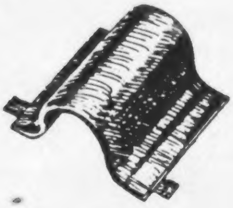


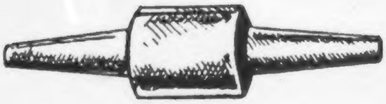
c. ______________________________ d. ______________________________





e. ______________________ f. ______________________





g. ______________________ h. ______________________

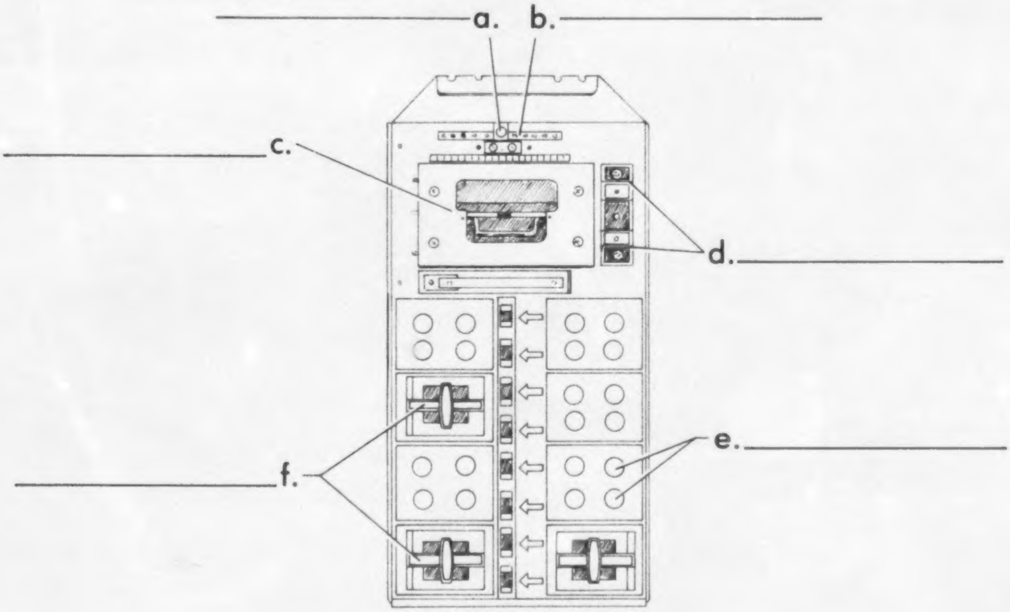
4. List three possible installations for load centers.

a.

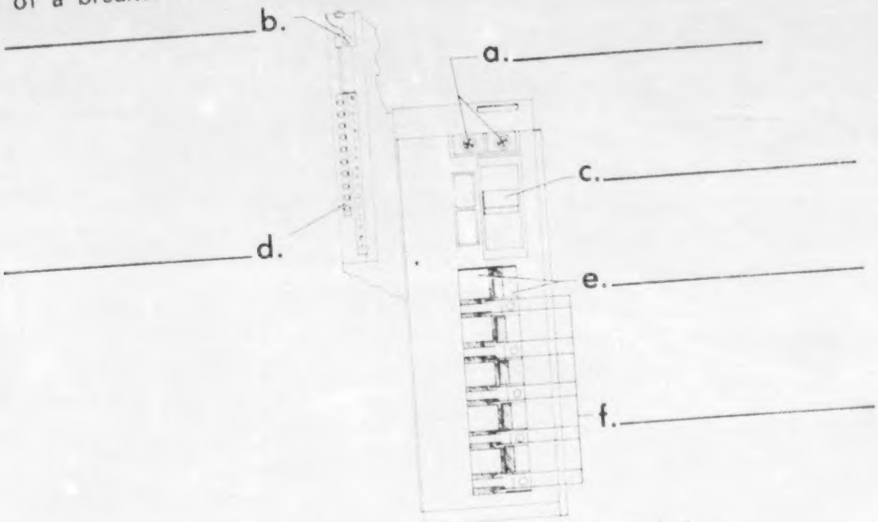
b.

c.

5. Identify the parts of a fusible load center.



6. Identify the parts of a breaker load center.



7. List five safety rules for working around load centers and safety switches.

a.

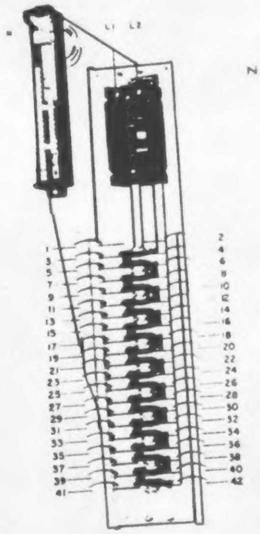
b.

c.

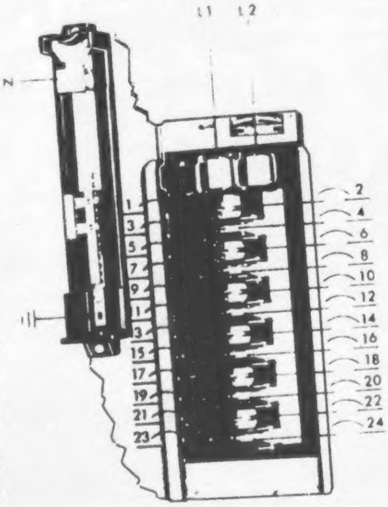
d.

e.

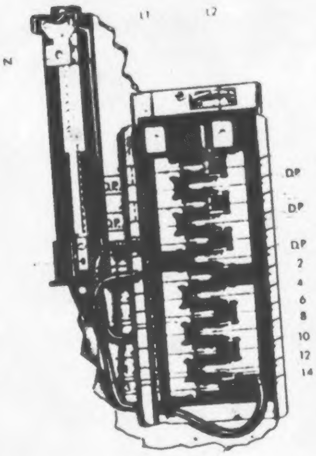
8. Identify common panel interior configurations.


L1 L2
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42

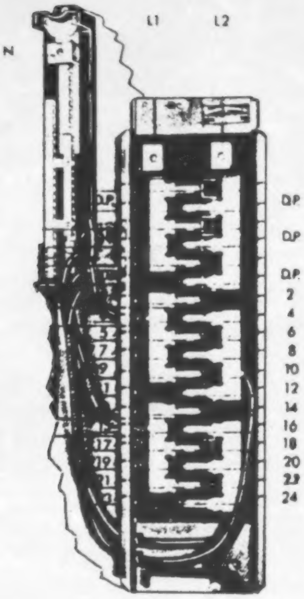
a. ____________


L1 L2
N
1 3 5 7 9 11 13 15 17 19 21 23
2 4 6 8 10 12 14 16 18 20 22 24

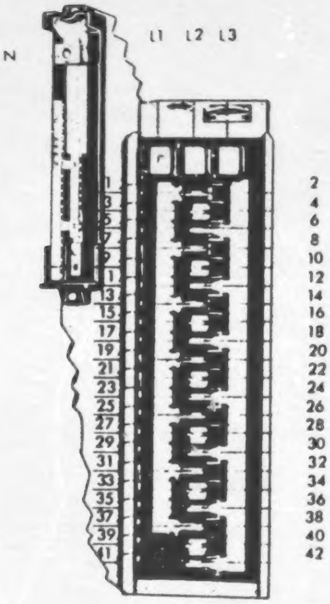
b. ____________


L1 L2
N
DP
DP
DP
2 4 6 8 10 12 14

c. ____________


N
L1
L2
D.P.
D.P.
D.P.

d. ______________________________


N
L1
L2
L3

e. ______________________________

LOAD CENTERS
UNIT III

ANSWERS TO TEST

1. a. 2
   b. 13
   c. 8
   d. 6
   e. 1
   f. 12
   g. 3
   h. 5
   i. 7
   j. 11
   k. 4
   l. 10
   m. 9

2. a. Indoor (NEMA Type 1)
   b. Raintight (NEMA Type 3R)

3. a. Grounding or grounded neutral bar
   b. Flush lock
   c. Closure plate
   d. Conduit hubs for rainproof exposures
   e. Lug
   f. Padlock attachment
   g. Lock off (for breakers)
   h. Handle tie

4. a. Flush (interior)
   b. Surface (interior)
   c. Exterior (surface)

5. a. Grounded lug (neutral)
   b. Grounded bar (neutral)
   c. Main fuse pullout
   d. Line lugs
   e. Plug fuse socket
   f. Pullouts

6. a. Main breaker line lugs
   b. Grounded lug (neutral)
   c. Main breaker
   d. Grounded bar (neutral)
   e. Bus bars
   f. Pole spaces
7. a. Don't tamper with or alter equipment
   b. Install for intended purpose
   c. Install according to NEC
   d. Don't hold extra tools in your hand during installation or maintenance
   e. Stand to the side of a disconnect before energizing it
8. a. Main breaker--Single phase
   b. No main--Single phase
   c. Split bus--Single phase
   d. Double split bus--Single phase
   e. No main--Three phase

OVERCURRENT PROTECTION
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms to their correct definitions, identify common types of overcurrent protection, and discuss the operation of various types of overcurrent devices. The student should also be able to list NEC requirements pertaining to the various types of overcurrent protection. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with overcurrent protection to the correct definitions.
2. Identify types of overcurrent protection devices.
3. Describe the operation of a single element fuse.
4. Describe the operation of a time delay fuse.
5. Describe the operation of a circuit breaker.
6. List six NEC requirements pertaining to fuses of less than 600v. 0v.
7. List four NEC requirements pertaining to circuit breakers of less than 600v.
8. List four residential installations that require ground fault interrupters.

OVERCURRENT PROTECTION
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information sheet.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Have student read Article 240 from the NEC.

   G. Show students examples of various types of overcurrent devices.

   H. Invite fuse or breaker sales representative to speak to class.

   I. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Read Article 240 from the NEC.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Overcurrent Protection Devices

      2. TM 2--How a Fuse Works

      3. TM 3--How a Time Delay Fuse Works

      4. TM 4--How a Circuit Breaker Works

D. Test

E. Answers to test

II. References:

A. *Maintaining the Lighting and Wiring System.* Athens, Georgia: American Association for Vocational Instructional Materials, 1971.

B. *Protection Handbook.* St. Louis, Missouri: Bussman M.F.G. Division/McGraw-Edison Co., 1972.

C. *National Electrical Code,* 1981. Boston: National Fire Protection Association, 1980.

OVERCURRENT PROTECTION
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Overcurrent protection--Weak link in the circuit that limits the amperage to a specified amount

B. Short circuit--Unintentional contact of a conductor

C. Circuit breaker--Automatic overcurrent device that trips on overloads or shorts and is resettable

D. Fuse--Overcurrent device which contains an element or elements which melt and open the circuit under a short or overload

E. Device--Electrical equipment that carries or transfers current but does not use it

F. Ground-fault circuit-interrupter--A device intended for the protection of personnel that functions to de-energize a circuit or portion there of within an extablished period of time when a current to ground exceeds some predetermined valve that is less than that required to operate the overcurrent protective device of the supply circuit

G. Ferrule type cartridge fuse--Fuse with metal caps on a cylindrical case

H. Edison base plug fuse--Fuse with a base that fits the same socket as a regular based incandescent bulb

(NOTE: Fuseholders of the Edison base type shall be installed only where they are made to accept type S fuses by the use of adapters.)

I. Type "S" plug fuse--Fuse with special size limiting characteristics for each amperage range

J. Blade type cartridge fuse--Fuse with flat contact blades on a cylindrical case

II. Types of overcurrent protection devices (Transparency 1)

A. Blade type cartridge fuse

B. Ferrule type cartridge fuse

C. Type "S" plug fuse

D. Edison base plug fuse

E. Circuit breaker

INFORMATION SHEET

III. Operation of a single element fuse (Transparency 2)

A. Fuses contain a current limiting link that will allow a set amount of current to exist in the circuit

B. When a short circuit or overload exists in the circuit the link becomes hot

C. The low melting point of the link causes it to break or open if the overload continues

IV. Operation of a time delay fuse (Transparency 3)

A. A time delay fuse has a spring loaded link which has one end embedded in a solder cup

B. A short circuit will cause the link to break

C. An overload will cause the solder holding the spring loaded link to soften

D. If the overload continues, the solder will soften enough to let the spring pull the link free and open the circuit

V. Operation of a circuit breaker (Transparency 4)

(NOTE: This explanation is of a thermally operated breaker.)

A. A circuit breaker has a set of internal contacts that are held together when the breaker is in the "on" position by a trigger

B. One contact is situated on a bimetallic strip which will be under rapid heat change due to the different expansion rates of the metal

C. If the heat becomes extreme enough due to an overload or short, the bending of the bimetallic strip will cause the trigger to trip and the circuit will open

VI. NEC requirements pertaining to fuses of less than 600v

(NOTE: NEC Article 240 pertains to requirements for fuses of less than 600v.)

A. Plug fuses shall not be used in circuits exceeding 125 volts between conductors

(NOTE: In a residence, plug fuses may be used for dual voltage applications.)

B. Fuses shall be marked with their amperage rating

C. Plug fuses shall be classified at not over 0 to 30 amperes

D. Edison base plug fuses can be used only as replacements

INFORMATION SHEET

E. Type "S" fuses (fustats) shall be classified at not over 125 volts

F. Type "S" fuses shall be classified at 0 to 15, 16 to 20, and 21 to 30 amperes

G. Different ampere classes of type "S" fuses are not interchangeable

H. Cartridge fuses shall be marked with their ampere rating, voltage rating, and the name or trademark of the manufacturer

VII. NEC requirements pertaining to circuit breakers of less than 600v

(NOTE: NEC Article 240 pertains to requirements for circuit breakers or less than 600v.)

A. Shall be capable of being manually tripped and set

(NOTE: Where used as switches in 120v flourescent lighting circuits, circuit breakers shall be approved for such switching duty and shall be marked "SWD.")

B. Will have a visible "off" and "on" indication

C. Shall be designed so that setting of tripping amperage requires dismantling if it is adjustable

D. Markings and ratings on breakers of less than 100 amperes shall be durable and visible after installation

VIII. Residential installations requiring ground fault interrupters

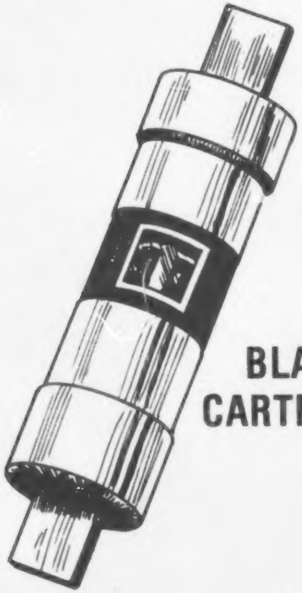
A. All 125 volt single phase, 15 or 20 ampere outdoor receptacles accessable from grade level

B. All 125 volt single phase, 15 or 20 ampere bathroom and garage receptacles

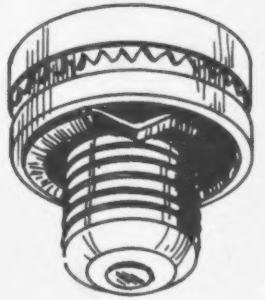
C. All 125 volt single phase, 15 or 20 ampere construction receptacles which are not a permanent part of the residence

D. Receptacles located within 15 feet of the inside walls of a swimming pool

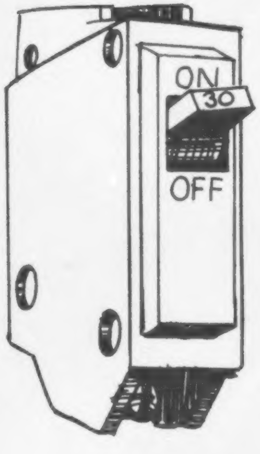
OVERCURRENT PROTECTION DEVICES



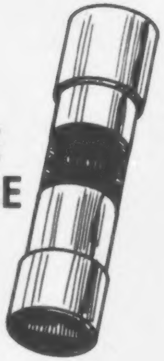
BLADE TYPE
CARTRIDGE FUSE



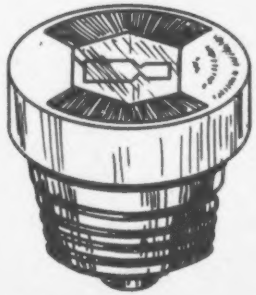
TYPE "S" PLUG FUSE



CIRCUIT BREAKER

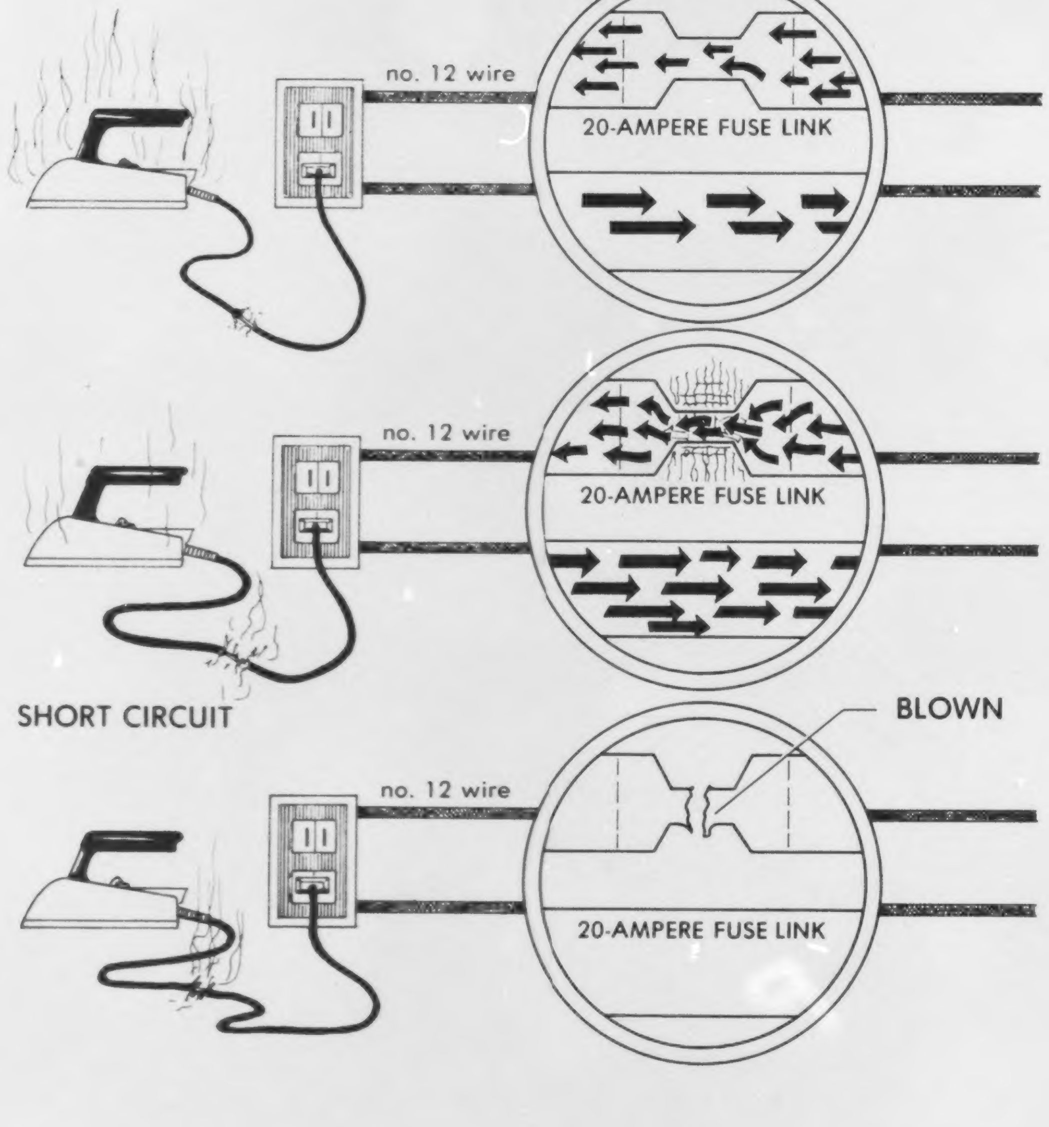


FERRULE TYPE
CARTRIDGE FUSE

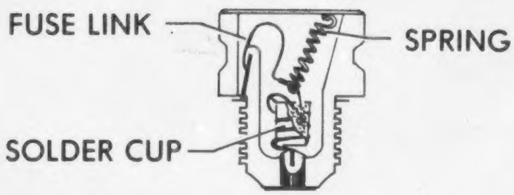


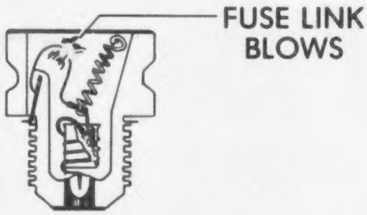
EDISON BASE PLUG FUSE

HOW A FUSE WORKS

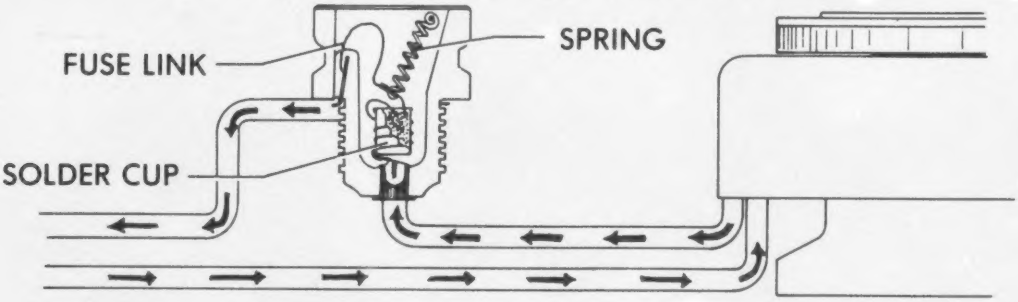

no. 12 wire
20-AMPERE FUSE LINK
no. 12 wire
20-AMPERE FUSE LINK
SHORT CIRCUIT
BLOWN
no. 12 wire
20-AMPERE FUSE LINK

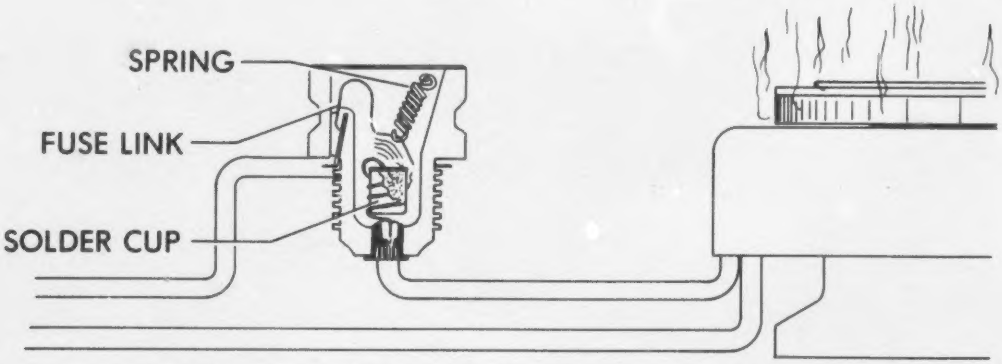
HOW A TIME DELAY FUSE WORKS


FUSE LINK
SPRING
SOLDER CUP


FUSE LINK BLOWS

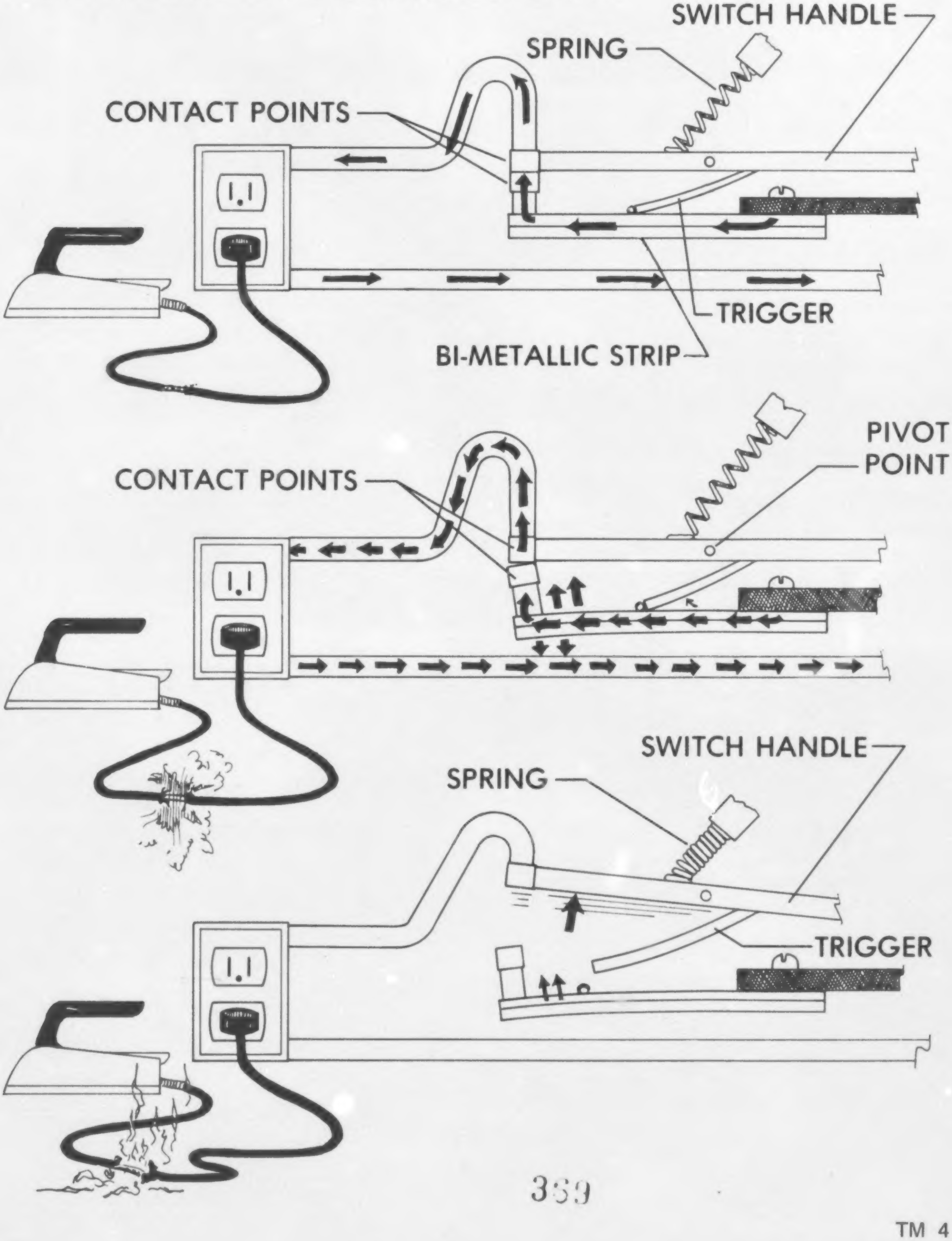
TEMPORARY OVERLOAD CAUSES SOLDER TO HEAT


FUSE LINK
SPRING
SOLDER CUP


SPRING
FUSE LINK
SOLDER CUP

CONTINUED OVERLOAD SOFTENS SOLDER -
SPRING PULLS FUSE LINK

HOW A CIRCUIT BREAKER WORKS


SWITCH HANDLE
SPRING
CONTACT POINTS
TRIGGER
BI-METALLIC STRIP
CONTACT POINTS
PIVOT POINT
SWITCH HANDLE
SPRING
TRIGGER

OVERCURRENT PROTECTION
UNIT I

NAME ______________________________

TEST

1. Match the terms on the right to their correct definitions.

______a. Fuse with a base that fits the same socket as a regular based incandescent bulb

______b. Overcurrent device which contains an element or elements which melt and open the circuit under a short or overload

______c. Weak link in the circuit that limits the amperage to a specified amount

______d. Fuse with special size limiting characteristics for each amperage range

______e. A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds some predetermined value that is less than required to operate the overcurrent protection device of the supply circuit

______f. Unintentional contact of a conductor

______g. Electrical equipment that carries or transfers current but does not use it

______h. Automatic overcurrent device that trips on overloads or shorts and and is resettable

______i. Fuse with metal caps on a cylindrical case

______j. Fuse with flat contact blades on a cylindrical case

1. Type "S" plug fuse
2. Device
3. Fuse
4. Overcurrent protection
5. Circuit breaker
6. Ferrule type cartridge fuse
7. Blade type cartridge fuse
8. Edison base plug fuse
9. Ground-fault circuit-interrupter
10. Short circuit

2. Identify the types of overcurrent protection devices pictured below.

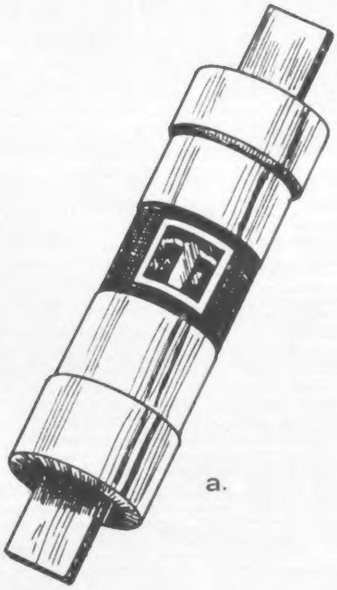
a.

b.

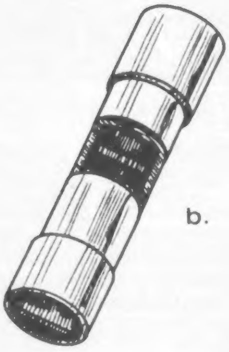
c.

d.

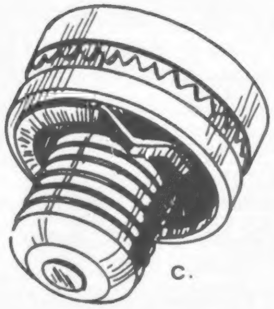
e.



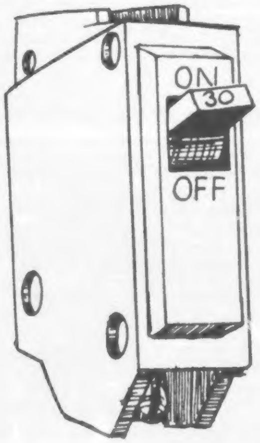
a.



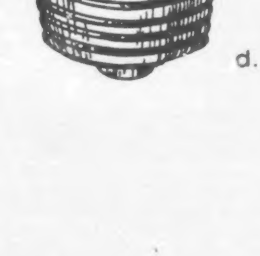
b.



c.



e.



d.

3. Describe the operation of a single element fuse.

4. Describe the operation of a time delay fuse.

5. Describe the operation of a circuit breaker.

6. List six NEC requirements pertaining to fuses of less than 600v.

a.

b.

c.

d.

e.

f.

7. List four NEC requirements pertaining to circuit breakers of less than 600v.

a.

b.

c.

d.

8. List four residential installations that require ground fault interrupters.

   a.

   b.

   c.

   d.

OVERCURRENT PROTECTION
UNIT I

ANSWERS TO TEST

1. a. 8
   b. 3
   c. 4
   d. 1
   e. 9
   f. 10
   g. 2
   h. 5
   i. 6
   j. 7
2. a. Blade type cartridge fuse
   b. Ferrule type cartridge fuse
   c. Type "S" plug fuse
   d. Edison base plug fuse
   e. Circuit breaker
3. Description should include:
   a. Fuses contain a current limiting link that will allow a set amount of current to exist in the circuit
   b. When a short circuit or overload exists in the circuit the link becomes hot
   c. The low melting point of the link causes it to break or open if the overload continues
4. Description should include:
   a. A time delay fuse has a spring loaded link which has one end embedded in a solder cup
   b. A short circuit will cause the link to break

c. An overload will cause the solder holding the spring loaded link to soften

d. If the overload continues, the solder will soften enough to let the spring pull the link free and open the circuit

5. Description should include:

a. A circuit breaker has a set of internal contacts that are held together when the breaker is in the "on" position by a trigger

b. One contact is situated on a bimetallic strip which will bend under rapid heat change due to the different expansion rates of the metal

c. If the heat becomes extreme enough due to an overload or short, the bending of the bimetallic strip will cause the trigger to trip and the circuit will open

6. Any six of the following:

a. Plug fuses shall not be used in circuits exceeding 125 volts between conductors

b. Fuses shall be marked with their amperage rating

c. Plug fuses shall be classified at not over 0 to 30 amperes

d. Edison base plug fuses can be used only as replacements

e. Type "S" fuses (fustats) shall be classified at not over 125 volts

f. Type "S" fuses shall be classified at 0 to 15, 16 to 20, and 21 to 30 amperes

g. Different ampere classes of type "S" fuses are not interchangeable

h. Cartridge fuses shall be marked with their ampere rating, voltage rating, and the name or trademark of the manufacturer

7. a. Shall be capable of being manually tripped and set

b. Will have a visible "off" and "on" indication

c. Shall be designed so that setting of tripping amperage requires dismantling if it is adjustable

d. Markings and ratings on breakers of less than 100 amperes shall be durable and visible after installation

8. a. All 120 volt single phase, 15 or 20 ampere outdoor receptacles accessable from grade level

   b. All 120 volt single phase, 15 or 20 ampere bathroom and garage receptacles

   c. All 120 volt single phase, 15 or 20 ampere construction receptacles which are not a permanent part of the residence

   d. Receptacles located within 15 feet of the inside walls of a swimming pool

NEW CONSTRUCTION: BOX LOCATION PLANNING AND INSTALLATION
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms associated with box location and placement to the correct definitions as well as list good planning techniques for box locating, accepted heights for boxes, procedures for installing boxes in veneered walls, proper box extension and methods for finding room centers. The student should also be able to locate boxes on a floor plan and install device and lighting outlet boxes. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with box location and placement to the correct definitions.
2. List five locations where at least one receptacle outlet is required.
3. List four good planning techniques when placing boxes on plans.
4. List accepted heights for boxes in various locations.
5. List the procedure for installing boxes in exterior walls to be brick veneered.
6. List proper box extensions for noncombustible and combustible wall surfaces.
7. List two common methods of finding room centers.
8. Locate receptacle, switch, and lighting outlets along floor lines and in the ceilings on a floor plan according to NEC minimum requirements.
9. Locate receptacle outlets along kitchen counters on a floor plan according to NEC minimum requirements.
10. Demonstrate the ability to:
    a. Install a device box when given cabinet height and wall covering.
    b. Install a lighting outlet box when given ceiling covering thickness

NEW CONSTRUCTION: BOX LOCATION PLANNING AND INSTALLATION
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information, assignment, and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information, assignment, and job sheets.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Take a field trip to a residential construction site where electrical rough-in is exposed.

   H. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete assignment and job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Placement of Electrical Outlets in the Kitchen

      2. TM 2--Box Locations (Outside Entrance and Exit)

      3. TM 3--Examples of Kitchen Dimensions (For Placement of Boxes)

4. TM 4--Flush Box Installation in Brick Veneer

5. TM 5--Installing Boxes (Flush Mount)

6. TM 6--Locating Center Points for Ceiling Outlet Boxes

7. TM 7--Electrical Floor Plan

D. Assignment sheets

1. Assignment Sheet #1--Locate Receptacle, Switch, and Lighting Outlets Along a Floor Line and the Ceiling on a Blueprint

2. Assignment Sheet #2--Locate Receptacle Outlets Along Kitchen Cabinets

E. Job sheets

1. Job Sheet #1--Install a Device Box When Given Cabinet Height and Wall Covering

2. Job Sheet #2--Install a Lighting Outlet Box When Given Ceiling Covering Thickness

F. Test

G. Answers to test

II. Reference--National Electrical Code, 1978. Boston: National Fire Protection Association, 1977.

NEW CONSTRUCTION: BOX LOCATION PLANNING AND INSTALLATION
UNIT II

INFORMATION SHEET

I. Terms and definitions

  A. Box center--Midpoint on a box's vertical dimension

  B. Room center--Point in a room that is equal distance from parallel walls

  C. Backsplash--That portion of a wall behind the kitchen cabinet, starting at the counter top and ending at the bottom of the wall hung cabinets

  D. Tile cap--Final tile in a ceramic backsplash when the tile is terminated at some point up the wall

  E. Box set out--Distance that the box extends past the stud

  F. Habitable--Suitable for people to occupy or live in

  G. Flush--Even with the surface

II. Locations where at least one receptacle outlet is required

  A. Bathroom--Adjacent to sink

  B. Laundry--Within six feet of appliance to be served

  C. Outside

  D. Basement

  E. Attached garage

III. Planning techniques when placing boxes on plans (Transparencies 1 and 2)

  A. Keep spacing even where possible

  B. Put boxes in even groups if possible

  C. Check door swing direction so switches are not behind doors

  D. Place outside lighting outlets low enough for any fixture

INFORMATION SHEET

IV. Accepted heights for boxes in various locations (Transparency 3)

(NOTE: You should ask the cabinetmaker how tall the cabinets are going to be when you are unfamiliar with the cabinetmaker's work.)

- A. Above kitchen counter tops--45" to box center

  (NOTE: Tops are usually 36"; 1/2 of 18" backsplash equals 9", total height is then 45".)

- B. Above bathroom cabinets--40" to box center

  (NOTE: This allows for a 44" or higher tile cap)

- C. Receptacles along floor line--12" to box centers

- D. Wall switches--48" to box centers

  (NOTE: This allows plasterboard installers to cut one half of box in each sheet when they run horizontal.)

V. Procedure for installing boxes in exterior walls to be brick veneered (Transparency 4)

(NOTE: Before installing any boxes in exterior brick walls check your local code.)

- A. Punch a small hole in wall sheeting

- B. Push cable through newly formed hole

- C. Put the cable through the back knockout of your box and secure with a cable clamp

  (NOTE: Leave plenty of cable so the mason can move the box to fit the masonry work.)

- D. Put screws in the device securing holes

  (NOTE: This keeps the screw holes from becoming filled with mortar.)

VI. Box extensions for noncombustible and combustible wall surfaces (Transparency 5)

- A. Noncombustible materials--Not more than 1/4" recess from surface

- B. Combustible materials--Flush with or projecting from surface

VII. Methods of finding room centers (Transparency 6)

- A. Corner to corner chalk line and plumb bob transfer

- B. Measuring half wall lengths, out at right angles from the walls

INFORMATION SHEET

VIII. Required outlets

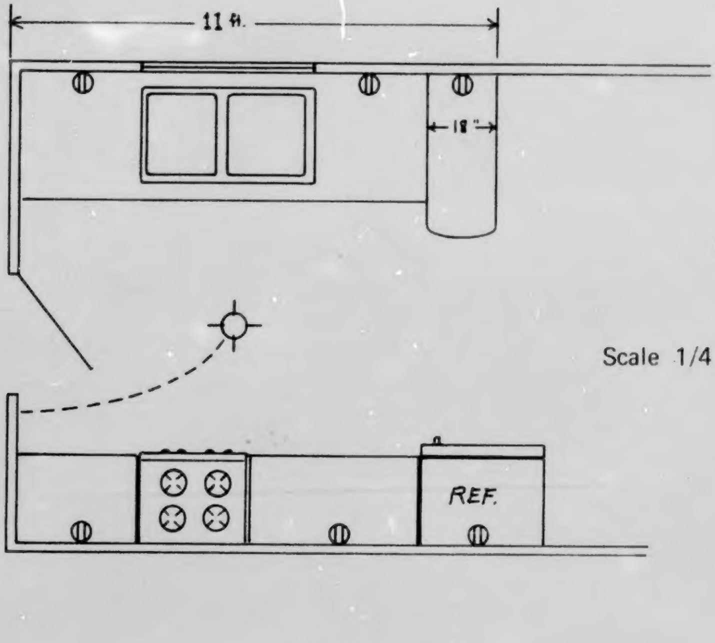
A. Receptacle outlets

1. General provisions--In every kitchen, family room, dining room, living room, or similar rooms of dwelling units, receptacle outlets shall be installed so that no point along the floor line in any wall space is more than 6 feet measured horizontally, from an outlet in that space, including any wall space 2 feet or more in width and the space occupied by sliding panels in exterior doors. The wall space afforded by fixed room dividers such as free standing bar type counters, shall be included in the 6' measurement

   (NOTE: A wall space shall be considered a wall unbroken along a floor line by doorways, fireplaces or similar openings. Each wall space 2 ft. wide or greater shall be treated individually and separately from other wall spaces. A wall space can include two or more walls (around corners) where unbroken at the floor line.)

2. Counter tops--In kitchen and dining areas of dwelling units a receptacle outlet shall be installed at each counter space wider than 12 inches

   (NOTE: Counters divided by ranges, sinks, or refrigerators shall be considered separate cabinets. The receptacle behind the refrigerator can be considered accessible.)



Scale 1/4 = 1"

INFORMATION SHEET

3. Bathrooms--At least one receptacle outlet shall be installed adjacent to the basin location

4. Outdoors--At least one receptacle outlet shall be installed outdoors

5. Laundry areas--At least one receptacle outlet shall be installed in laundry areas

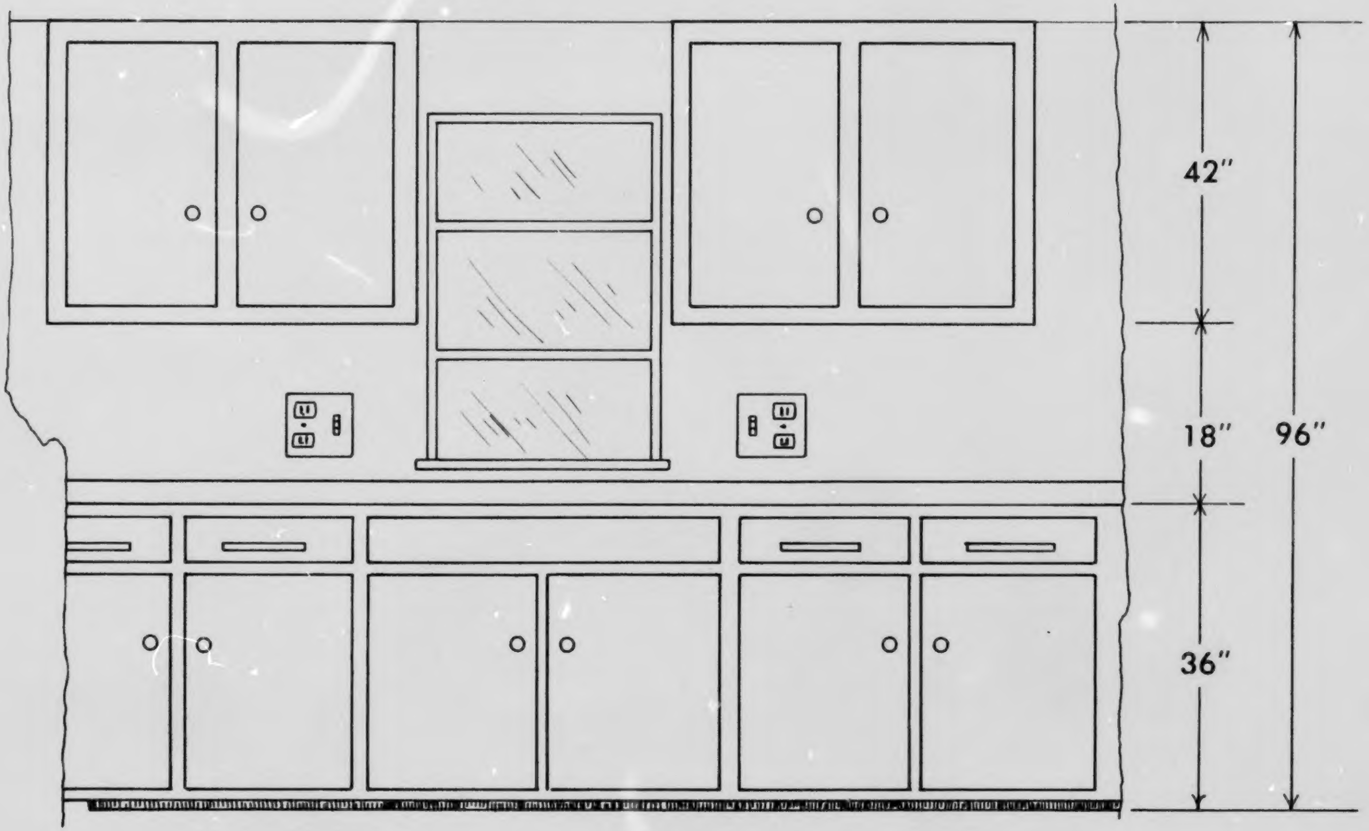
6. Basements and attached garages--At least one receptacle outlet shall be installed in addition to any for laundry equipment

B. Lighting outlets required--At least one wall switch controlling a lighting outlet in every habitable room, hallway, bathroom, stairway, attached garage, outdoor entrance, and in attics, under floor space, utility rooms and basements if used for storage or if containing equipment requiring service

(NOTE: In habitable rooms, other than kitchens or bathrooms, one or more receptacles controlled by a wall switch shall be permitted in lieu of lighting outlets.)

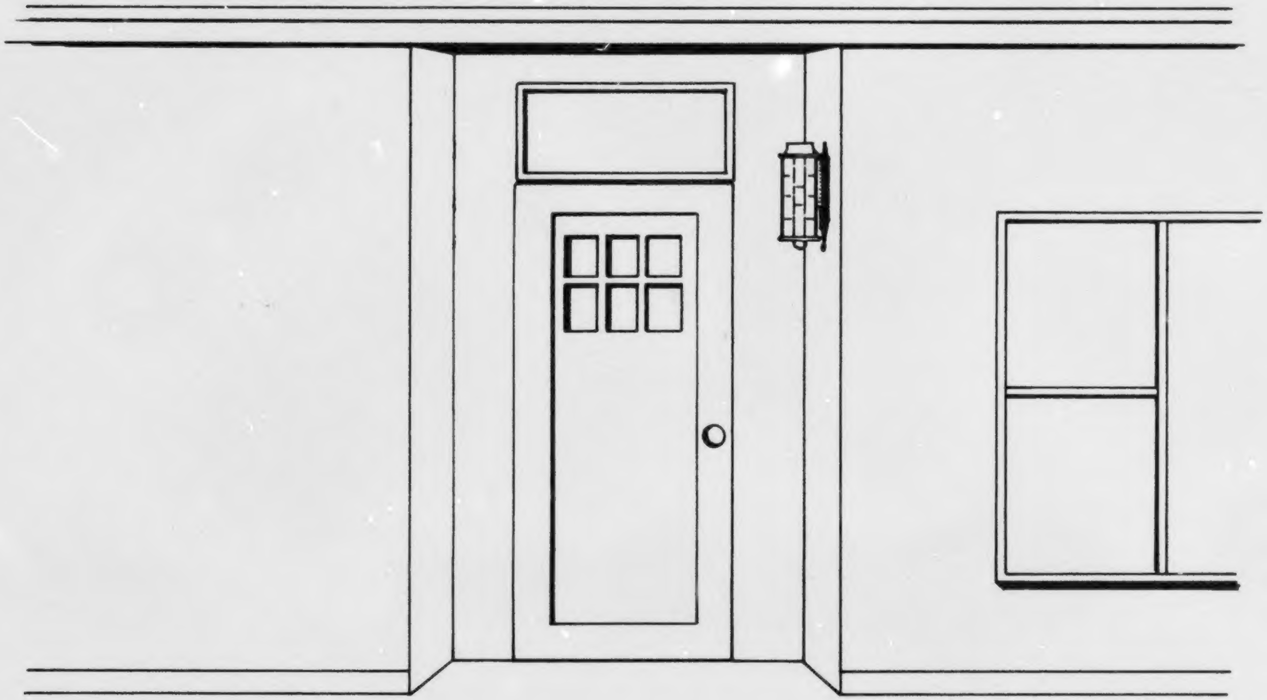
Placement of Electrical Outlets in the Kitchen

PUTTING SWITCHES AND RECEPTACLES IN EVEN GROUPS MAKES THE JOB LOOK PLANNED

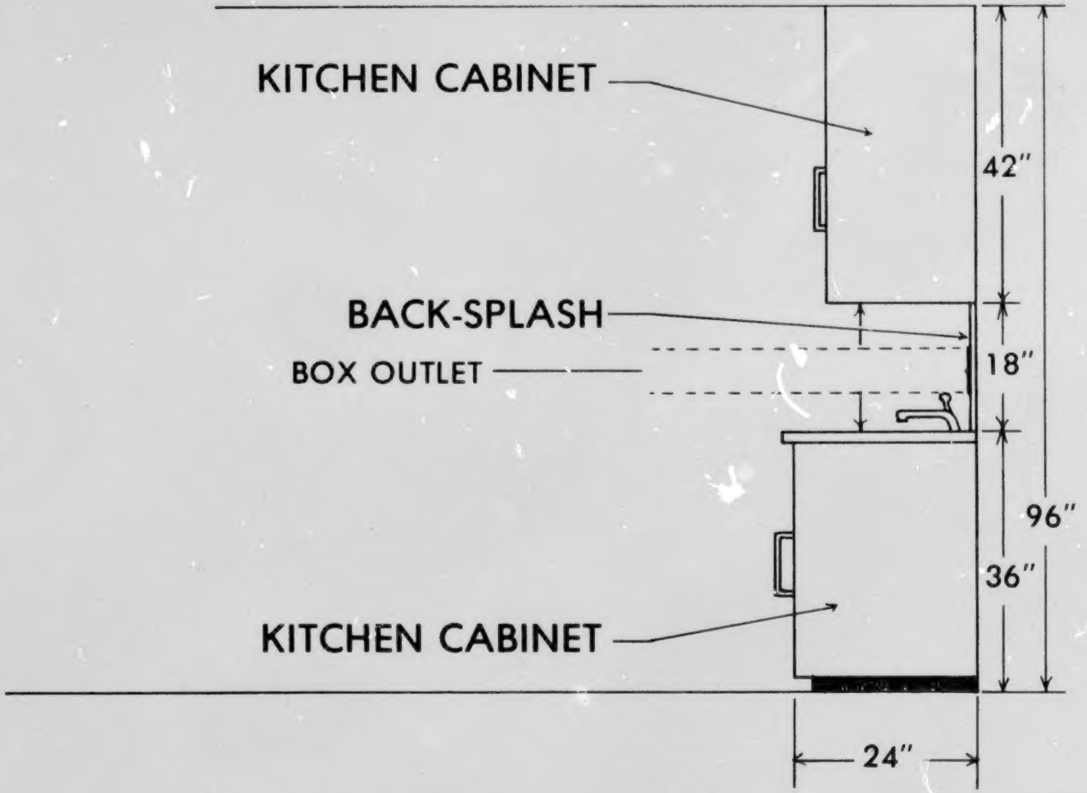


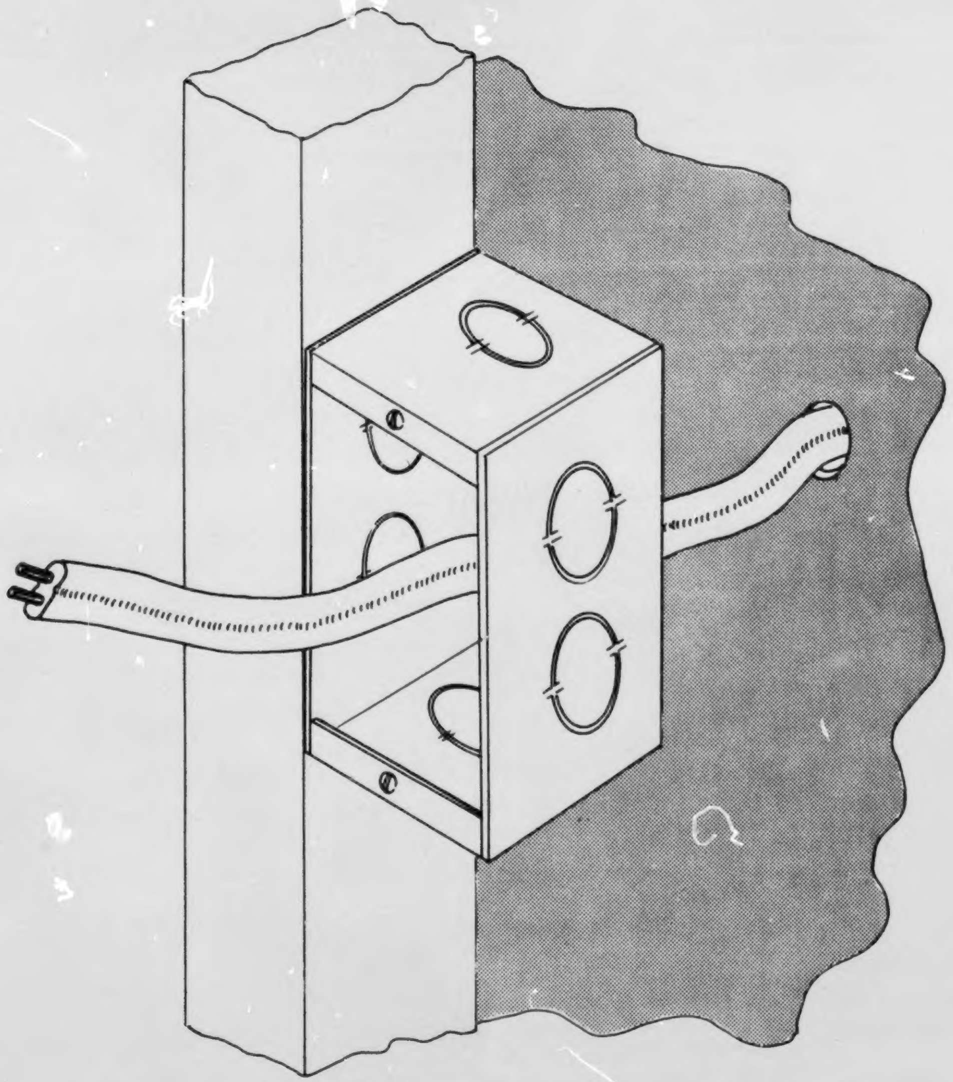
BOX LOCATIONS (OUTSIDE ENTRANCE AND EXIT)

KEEPING BOXES AT LEAST TWO FEET FROM THE TOP PLATE WILL ALLOW FULL VIEW OF THE LARGER FIXTURES



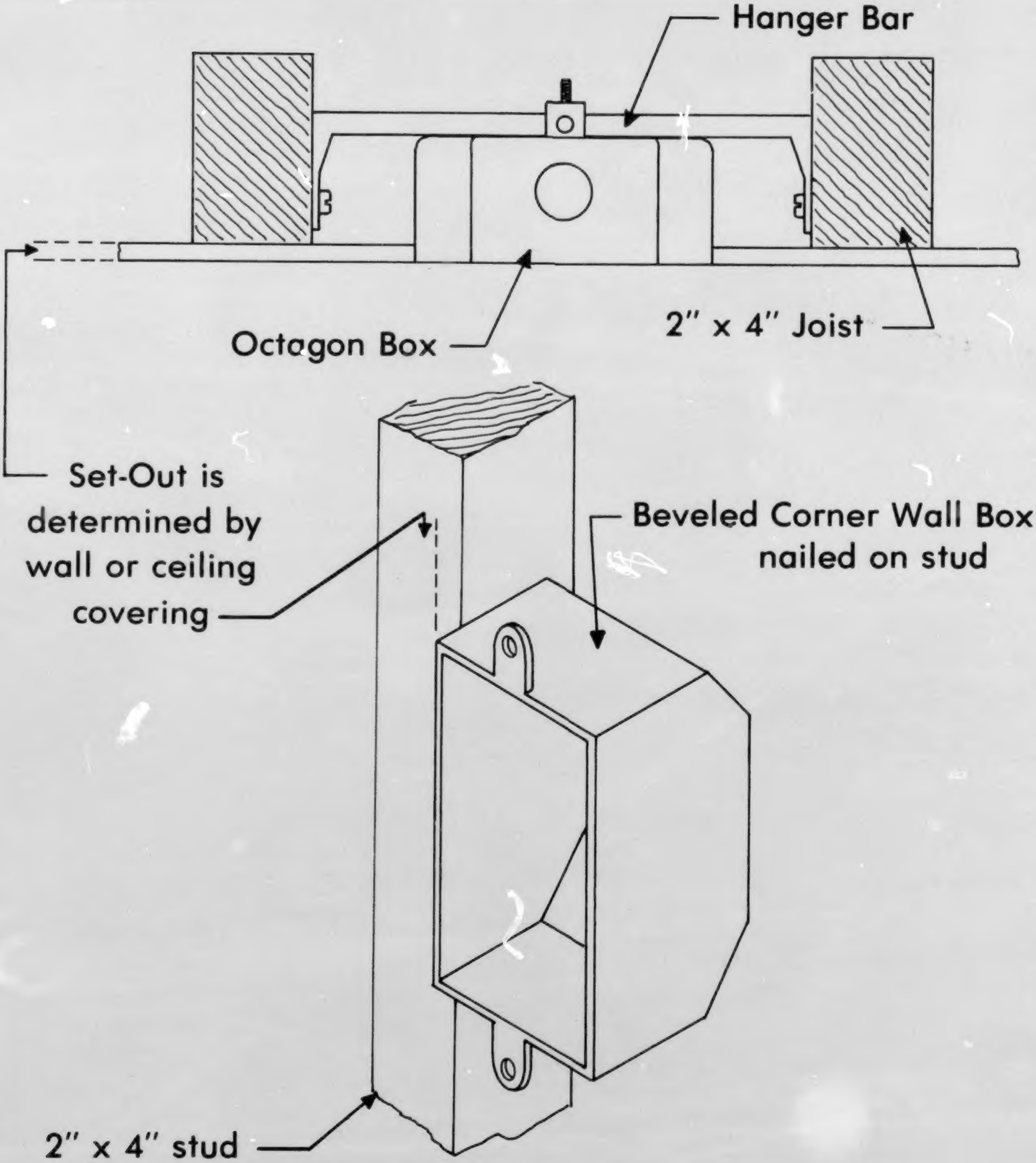
EXAMPLES OF KITCHEN DIMENSIONS (FOR PLACEMENT OF BOXES)


KITCHEN CABINET
BACK-SPLASH
BOX OUTLET
KITCHEN CABINET
42″
18″
96″
36″
24″

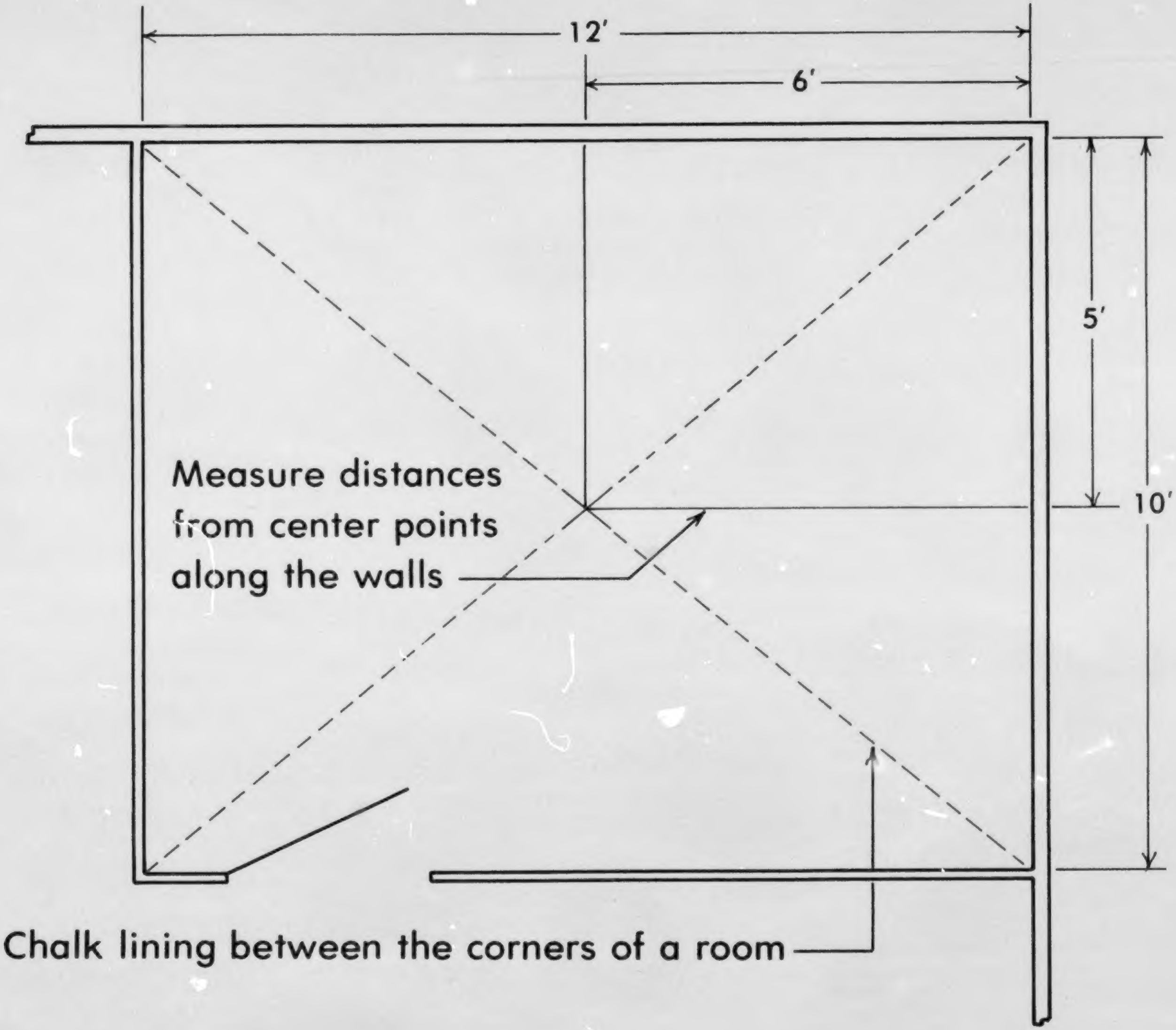


FLUSH BOX INSTALLATION IN BRICK VENEER

INSTALLING BOXES (FLUSH MOUNT)

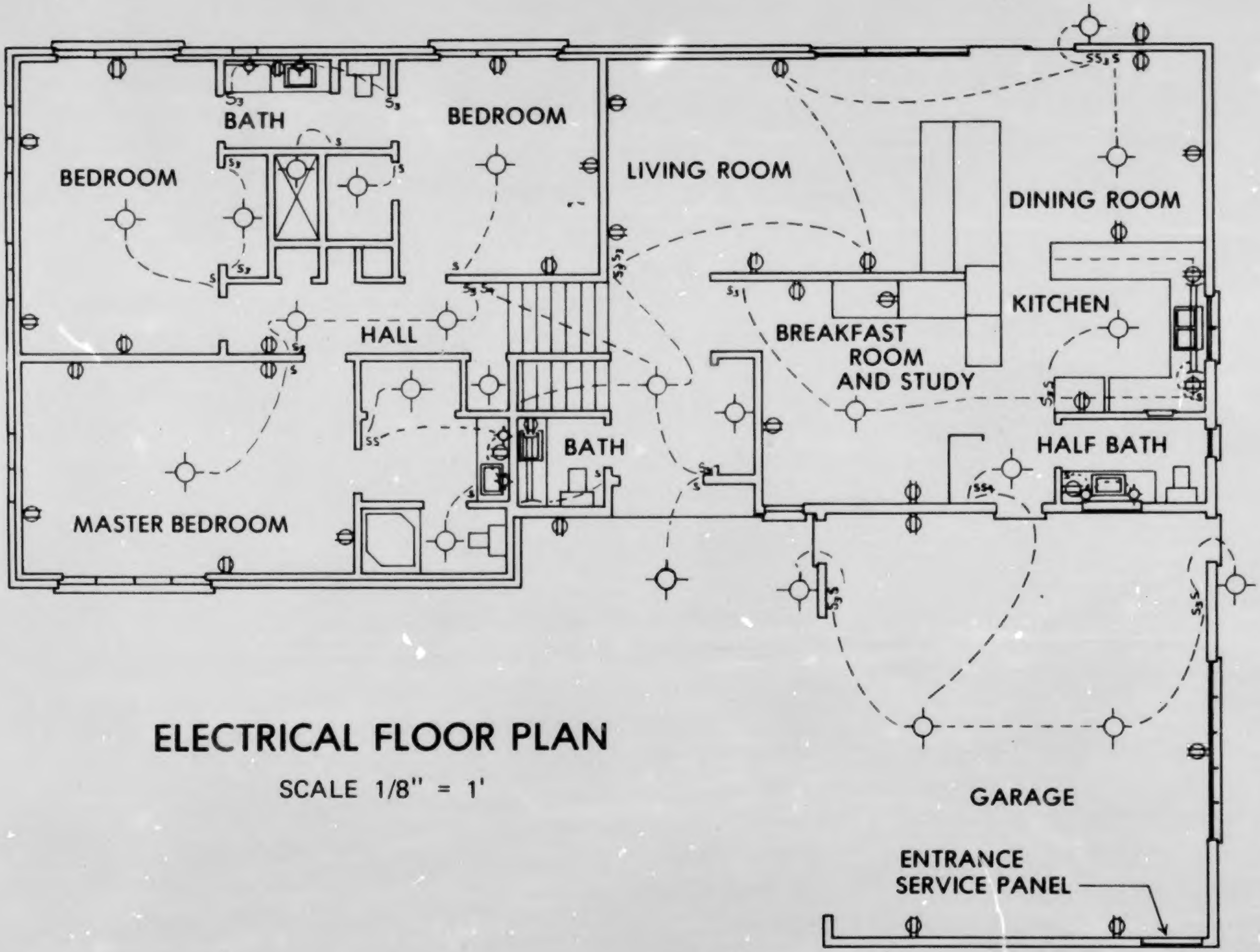

Hanger Bar
2" x 4" Joist
Octagon Box
Set-Out is determined by wall or ceiling covering
Beveled Corner Wall Box nailed on stud
2" x 4" stud

LOCATING CENTER POINTS FOR CEILING OUTLET BOXES



Measure distances from center points along the walls

Chalk lining between the corners of a room


BATH
BEDROOM
BEDROOM
LIVING ROOM
DINING ROOM
KITCHEN
HALL
BREAKFAST ROOM AND STUDY
BATH
HALF BATH
MASTER BEDROOM
GARAGE
ENTRANCE SERVICE PANEL

ELECTRICAL FLOOR PLAN

SCALE 1/8" = 1'

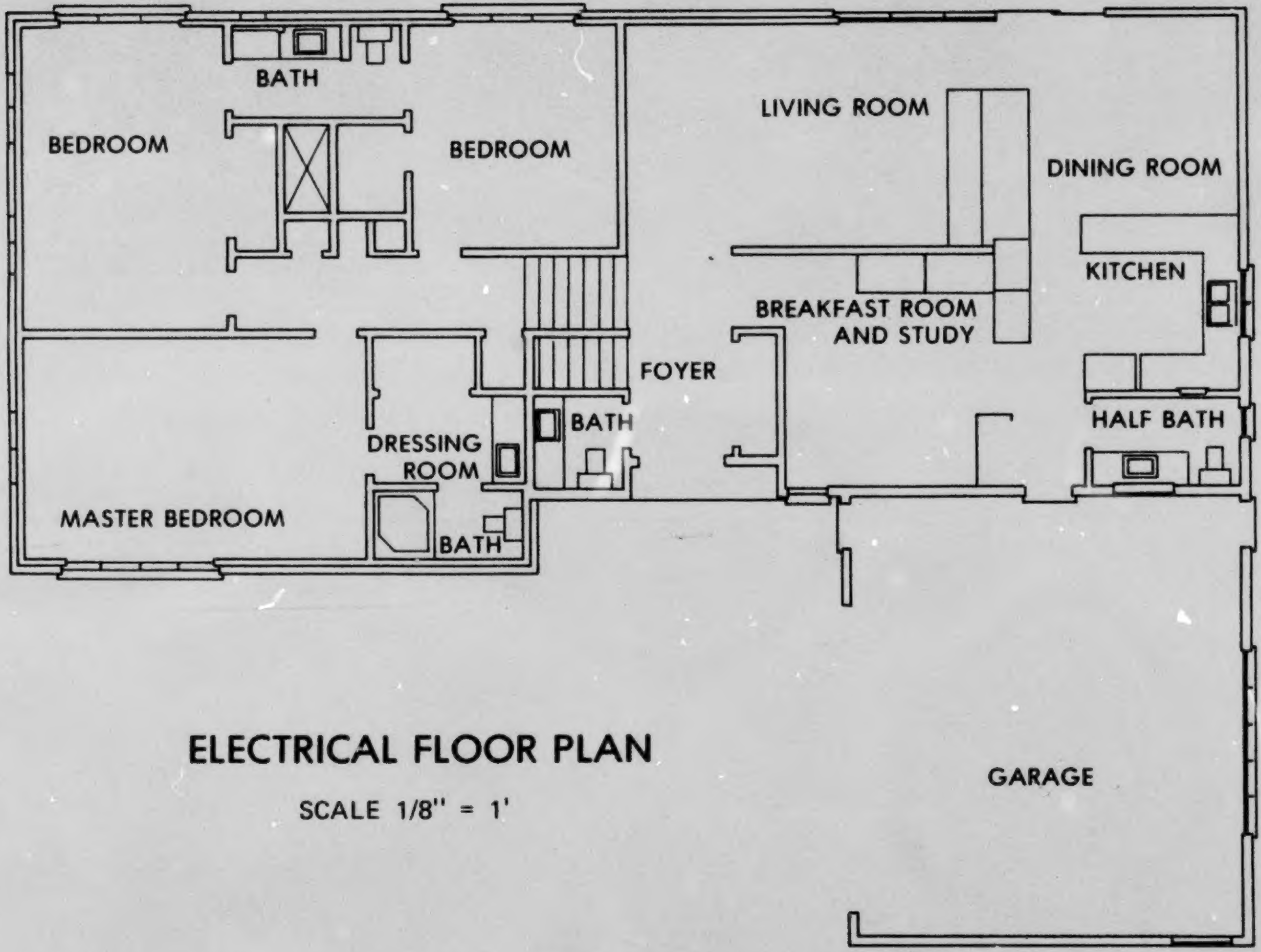
395

396

NEW CONSTRUCTION: BOX LOCATION PLANNING AND INSTALLATION
UNIT II

ASSIGNMENT SHEET #1--LOCATE RECEPTACLE, SWITCH, AND LIGHTING OUTLETS ALONG A FLOOR LINE AND THE CEILING ON A BLUEPRINT

Using appropriate blueprint symbols, locate the minimum required receptacle switch and lighting outlets along the floor line and in the ceiling on the plan on the following page.


BATH
BEDROOM
BEDROOM
LIVING ROOM
DINING ROOM
KITCHEN
BREAKFAST ROOM AND STUDY
FOYER
BATH
DRESSING ROOM
HALF BATH
MASTER BEDROOM
BATH
GARAGE

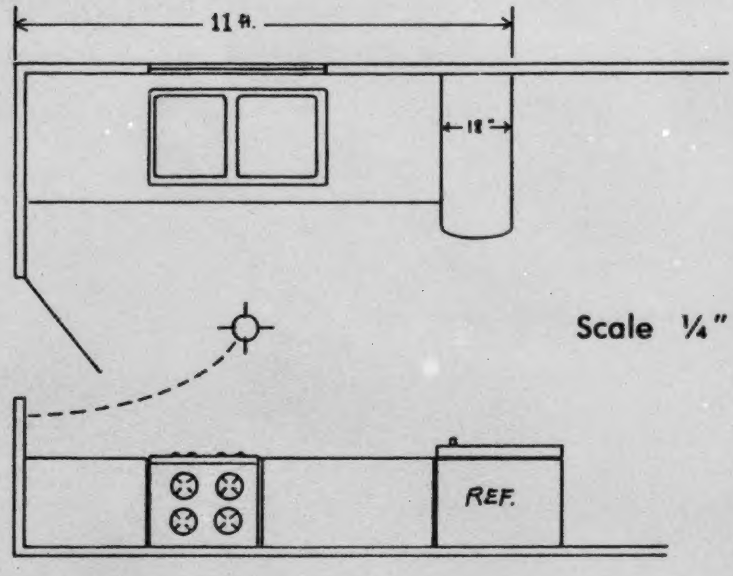
ELECTRICAL FLOOR PLAN

SCALE 1/8'' = 1'

NEW CONSTRUCTION: BOX LOCATION PLANNING AND INSTALLATION
UNIT II

ASSIGNMENT SHEET #2--LOCATE RECEPTACLE OUTLETS ALONG KITCHEN CABINETS

Using appropriate blueprint symbols, locate the minimum required receptacle outlets along the cabinet spaces on the print below.



Scale ¼" = 1"

NEW CONSTRUCTION: BOX LOCATION PLANNING AND INSTALLATION
UNIT II

JOB SHEET #1--INSTALL A DEVICE BOX WHEN GIVEN CABINET HEIGHT AND WALL COVERING

Locate a device box in a backsplash behind a 36" high counter. The hanging cabinets start 18" from the counter top. The wall will be covered with 1/2" plasterboard.

I. Tools and equipment

   A. Rule

   B. Device box

   C. Hammer

   D. Nails

   (NOTE: Some device boxes have nails already attached to the box. If so, no other nails are necessary.)

   E. Stud wall

   (NOTE: This can be in a new house or a shop mock-up of an unfinished wall with studs exposed.)

   F. Safety glasses

   G. Pencil

II. Procedure

   A. Gather tools and materials

   B. Determine box height and mark the stud for your box center (Figure 1)

   (NOTE: In this job 45" will be acceptable. That is 36" cabinet height plus 1/2 of backsplash which is 9" (18/2))

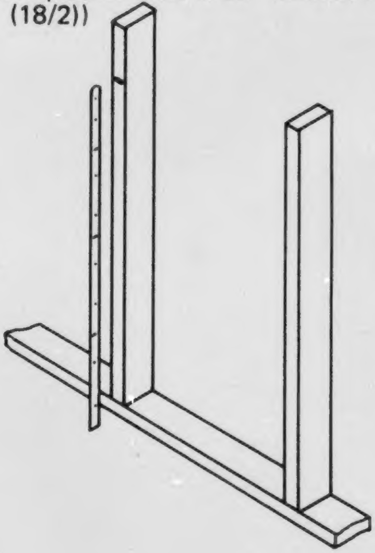


FIGURE 1

JOB SHEET #1

C. Determine appropriate box set out for wall covering specified

(NOTE: In this instance for a noncombustable wall, set out is between one quarter and one half inch.)

D. Locate box on center with correct set out (Figure 2)

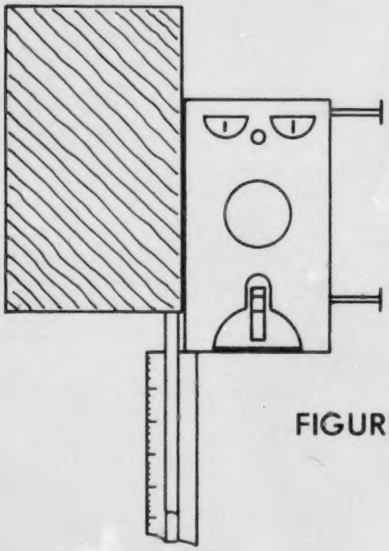


FIGURE 2

E. Drive nails in to secure box

F. Check set out again

NEW CONSTRUCTION: BOX LOCATION PLANNING AND INSTALLATION
UNIT II

JOB SHEET #2--INSTALL A LIGHTING OUTLET BOX WHEN GIVEN CEILING COVERING THICKNESS

I. Tools and equipment

(NOTE: The lighting outlet box is to be installed in a wall to be covered with 1/2" plasterboard.)

A. Rule

B. 4" octagon box

(NOTE: Any type lighting outlet box can be used for this installation.)

C. Hammer

D. Bar hanger

(NOTE: Bar hangers come in various lengths. You need to have a hanger that will fit between your studs.)

E. Nails

F. Stud wall

G. Safety glasses

H. Pencil

II. Procedure

(NOTE: The lighting outlet box is to be installed in a wall to be covered with 1/2" plasterboard.)

A. Collect tools and equipment

B. Remove center knock-out from the back of your box (Figure 1)

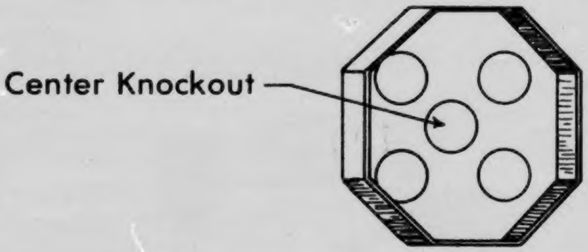


FIGURE 1

JOB SHEET #2

C. Remove attachment screw and spacer from bar hanger (Figure 2)

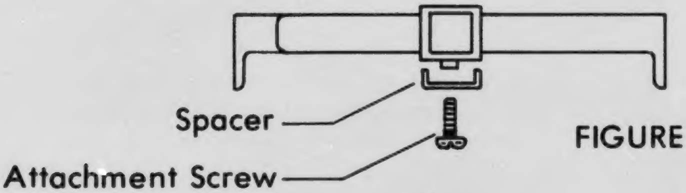


FIGURE 2

D. Mount your box on the bar hanger and secure it loosely with your spacer and attachment screw (Figure 3)

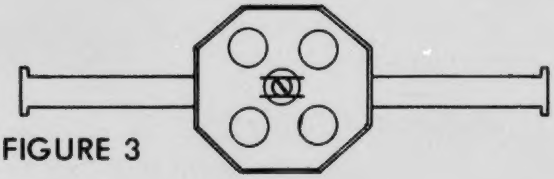


FIGURE 3

E. Place bar and box between stud and check set out (Figure 4)

(NOTE: Set out should be between 1/4" and 1/2".)

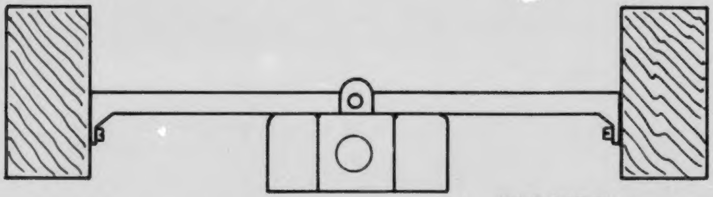


FIGURE 4

F. Nail hanger in place

G. Check set out again

NEW CONSTRUCTION: BOX LOCATION PLANNING AND INSTALLATION
UNIT II

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Final tile in a ceramic backsplash when the tile is terminated at some point prior to the top	1.	Room center
	2.	Tile cap
_____b. Midpoint on a box's vertical dimension	3.	Flush
_____c. Distance that the box extends past the stud	4.	Box set out
	5.	Backsplash
_____d. Even with the surface	6.	Box center
_____e. Point in a room that is equal distance from parallel walls	7.	Habitable
_____f. Suitable for people to occupy or live in		
_____g. That portion of a wall behind the kitchen cabinet starting at the counter top and ending at the bottom of the wall hung cabinets		

2. List five locations where at least one receptacle outlet is required.

a.

b.

c.

d.

e.

3. List four good planning techniques when placing boxes on plans.

a.

b.

c.

d.

4. List accepted heights for boxes in various locations.

    a. Above kitchen counter tops--

    b. Above bathroom cabinets--

    c. Receptacles along floor line--

    d. Wall switches--

5. List the procedure for installing boxes in exterior walls to be brick veneered.

    a.

    b.

    c.

    d.

6. List proper box extension for various wall surfaces.

    a. Noncombustible materials--

    b. Combustible materials--

7. List two common methods of finding room centers.

    a.

    b.

8. Locate receptacle, switch, and lighting outlets along floor lines and in the ceilings on a floor plan according to NEC minimum requirements.

9. Locate receptacle outlets along kitchen counters on a floor plan according to NEC minimum requirements.

10. Demonstrate the ability to:

    a. Install a device box when given cabinet heights and wall coverings.

    b. Install a lighting outlet box when given ceiling covering thickness.

    (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

NEW CONSTRUCTION: BOX LOCATION PLANNING AND INSTALLATION
UNIT II

ANSWERS TO TEST

1. a. 2
   b. 6
   c. 4
   d. 3
   e. 1
   f. 7
   g. 5
2. a. Bathroom--Adjacent to sink
   b. Laundry--Within six feet of appliance to be served
   c. Outside
   d. Basement
   e. Attached garage
3. a. Keep spacing even where possible
   b. Put boxes in even groups if possible
   c. Check door swing direction so switches are not behind doors
   d. Place outside lighting outlets low enough for any fixture
4. a. Above kitchen counter tops--45" to box center
   b. Above bathroom cabinets--40" to box center
   c. Receptacles along floor line--12" to box center
   d. Wall switches--48" to box centers
5. a. Punch a small hole in wall sheeting
   b. Push cable through newly formed hole
   c. Put the cable through the back knockout of your box and secure with a cable clamp
   d. Put screws in the device securing holes

6. a. Noncombustable materials--Not more than 1/4" recess from surface
   b. Combustible materials--Flush with or projecting from surface
7. a. Corner to corner chalk line and plumb bob transfer
   b. Measuring half wall lengths out at right angles from the walls
8. Evaluated to the satisfaction of the instructor.
9. Evaluated to the satisfaction of the instructor.
10. Performance skills evaluated to the satisfaction of the instructor.

SWITCHING SITUATIONS
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms to their definitions, list steps for determining appropriate box size and steps for grounding devices and boxes. The student should also be able to determine which box is needed and wire various switching situations. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with switching situations to the correct definitions.
2. List the six steps for determining appropriate box size.
3. List the four requirements for terminal identification.
4. List the five steps for grounding devices and boxes.
5. Identify the parts of various switching circuits.
6. Determine metal box size when given the number and size of conductors to be installed.
7. Demonstrate the ability to:
    a. Wire a single pole switch controlling a single lighting outlet with the supply line entering the switch box.
    b. Wire a single pole switch controlling a single lighting outlet with the supply line entering the lighting outlet box.
    c. Wire a three way switching situation with the supply entering a single lighting outlet box.
    d. Wire a four way switching situation with the supply entering the lighting outlet box.

SWITCHING SITUATIONS
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information, assignment, and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Demonstrate and discuss the procedures outlined on the job sheets.

  G. Take students on field trip to a residential rough-in.

  H. Relate code requirements on box fill calculations using volume.

  I. Demonstrate and discuss the use of plaster rings.

  J. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete assignment and job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Grounding Devices and Boxes

    2. TM 2--Parts of Switching Circuits

D. Assignment Sheet #1--Determine Box Size When Given the Number and Size of Conductors to be Installed

E. Answers to assignment sheet

F. Job sheets

   1. Job Sheet #1--Wire a Single Pole Switch Controlling a Single Lighting Outlet with the Supply Line Entering the Switch Box

   2. Job Sheet #2--Wire a Single Pole Switch Controlling a Single Lighting Outlet with the Supply Line Entering the Lighting Outlet

   3. Job Sheet #3--Wire a Three Way Switching Situation with the Supply Entering a Single Lighting Outlet

   4. Job Sheet #4--Wire a Four Way Switching Situation with the Supply Entering the Lighting Outlet Box

G. Test

H. Answers to test

II. Reference--*National Electrical Code* 1981. Boston: National Fire Protection Association, 1980.

SWITCHING SITUATIONS
UNIT III

INFORMATION SHEET

I. Terms and definitions

   A. Switch--Device used to open or transfer circuit direction

   B. Switch loop--Conductors between light and switch when supply enters the light

   C. Switch leg--Conductor that supplies electrical energy to a switch

   D. Return leg--Conductor that carries electrical energy from the switch to the load

   (NOTE: Terminology relating to these conductors may vary in the field.)

   E. Traveler--Transfer conductors in a switching situation; they are used between 3-ways and 4-ways

   F. Device--Unit of an electrical system which is intended to carry but not utilize electrical energy

   G. Strap--Metal strip which contains one or more devices

   H. Hickey--Threaded nipple used for hanging fixtures

   I. Terminal--Point of attachment for conductors

   J. Cable clamp--Piece of equipment used to secure cables

II. Steps for determining box size

   (NOTE: NEC Article 370 deals with determining box size.)

   A. Determine number of conductors (other than grounding) to be contained in the box

   B. Determine size of conductors to be used

   C. Determine if any fixture studs, cable clamps, or hickeys are to be contained in the box and count as one conductor

   D. Determine number of straps containing devices to be attached and count as one conductor per strap

   E. Determine if grounding conductors will enter box and count as one

   F. Add total A, C, D, and E and refer to NEC table in Article 370 using wire size determined in "B"

INFORMATION SHEET

III. Requirements for terminal identification

(NOTE: Requirements for terminal identification can be found in NEC Article 200. Single pole switches have no device terminal identification.)

A. All grounding terminals shall be green and hex headed

B. Traveler terminals on three way switches shall be the same color, and different from the controlling or common terminal

C. Neutral conductors and terminals shall be white, silver, or labeled with the word white or letter W

D. Ungrounded conductors--Usually copper colored but could be any color other than those already designated

IV. Grounding devices and boxes (Transparency 1)

A. Group and solidly connect all grounding conductors

B. Connection shall be made from the grounding conductors to a green hex headed screw or other device to ground all metal boxes

C. Grounding terminals on devices shall be connected to metal boxes by a bonding jumper to metal boxes for flush installations

(NOTE: This connection shall be made in a manner that will allow for the removal of the device without breaking the continuity between the conductors and the box.)

D. On surface boxes the metal to metal contact between the device and box shall serve as the grounding bond

E. In plastic boxes group the grounding conductors and connect them to the device grounding terminal

V. Parts of various switching circuits (Transparency 2)

A. Neutral conductor

B. Switch leg

C. Return leg

D. Travelers

E. Lamp or load

F. Three way switch

INFORMATION SHEET

G. Four way switch

H. Lighting outlet box

I. Device box

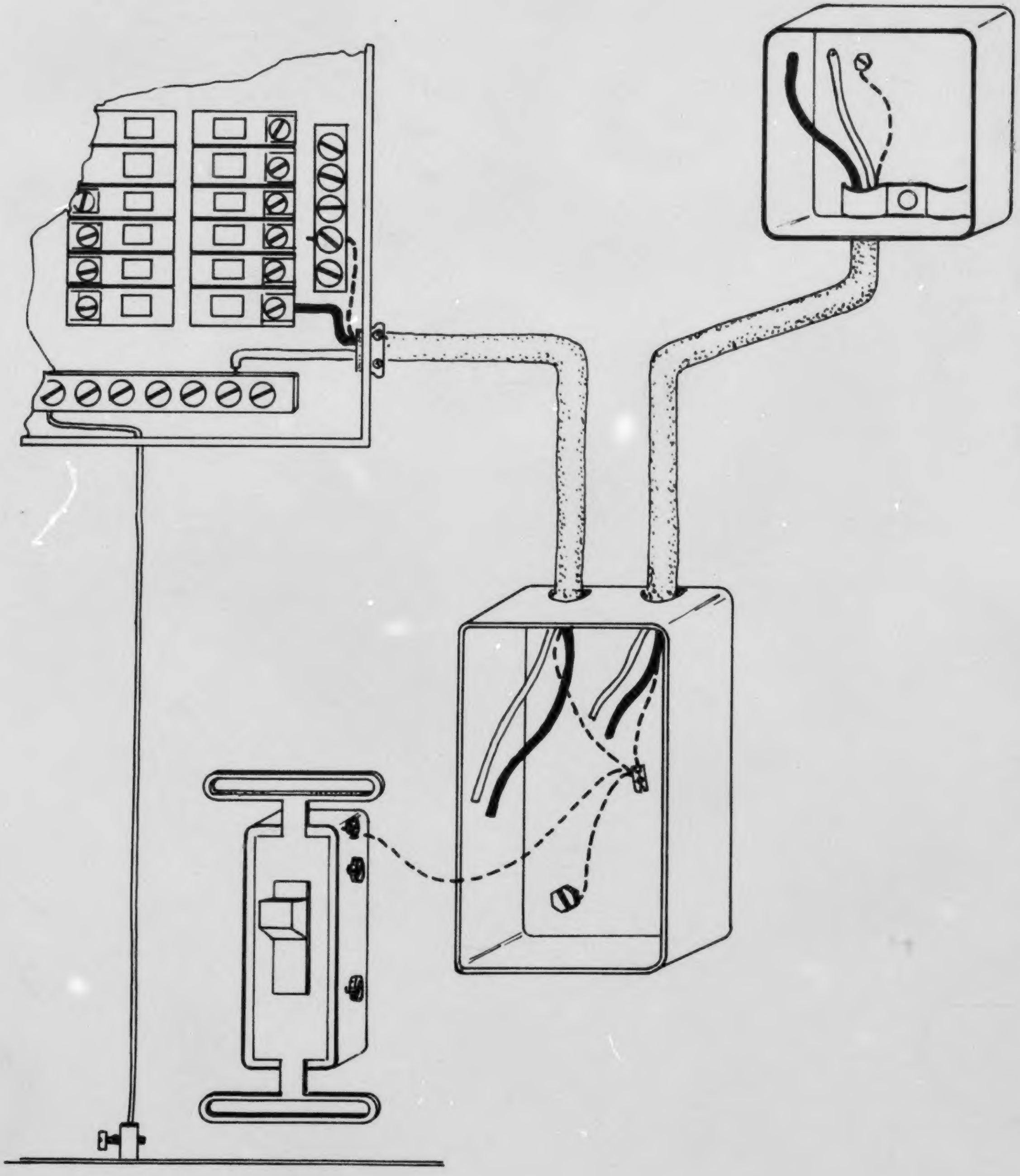
J. Grounding conductor

K. Neutral

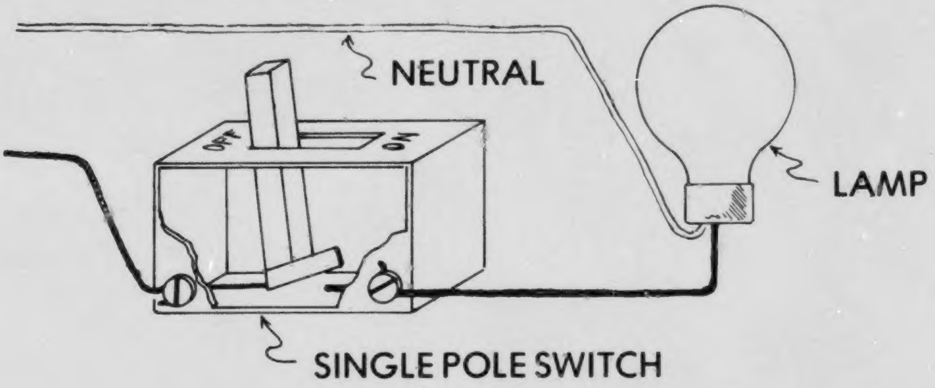
L. Three way switch

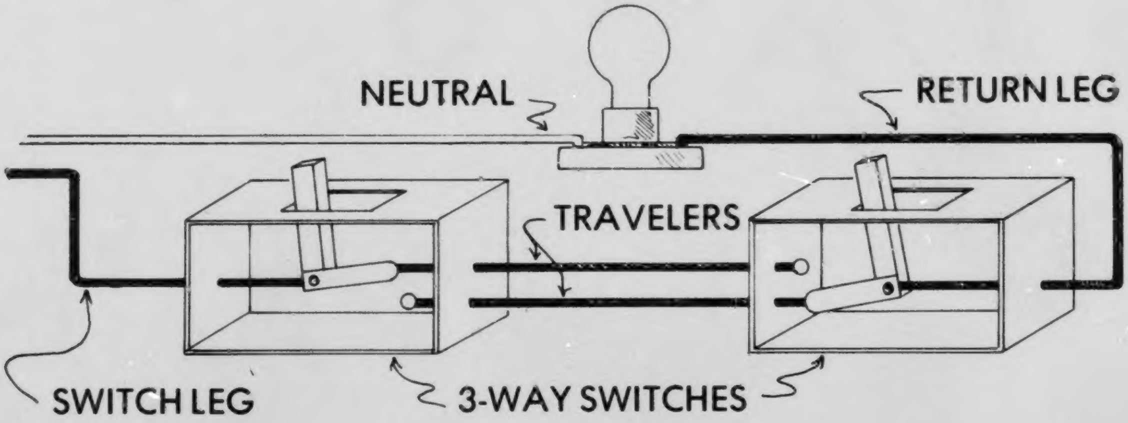
M. Four way switch

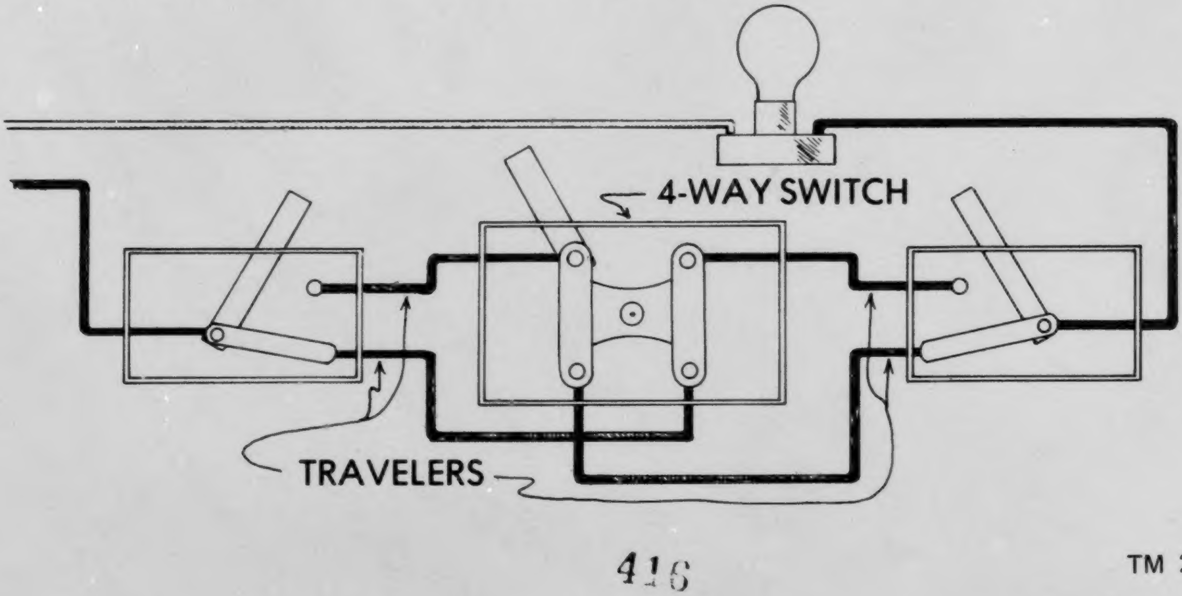
GROUNDING DEVICES AND BOXES



PARTS OF SWITCHING CIRCUITS


NEUTRAL
OFF
ON
LAMP
SINGLE POLE SWITCH


NEUTRAL
RETURN LEG
TRAVELERS
SWITCH LEG
3-WAY SWITCHES


4-WAY SWITCH
TRAVELERS

SWITCHING SITUATIONS
UNIT III

ASSIGNMENT SHEET #1--DETERMINE METAL BOX SIZE WHEN GIVEN THE NUMBER AND SIZE OF CONDUCTORS TO BE INSTALLED

Directions: From the information given select the box size that best suits your needs.

Example:

Box Type	Conductors	Grounding conductors	Straps	Clamps or hickeys	Total
A. Device	4#12	2#12	1	2	7

Total conductors equals 4 plus 1 for grounding plus 1 for straps plus 1 for hickeys or clamp, a total of 7 #12 conductors. Referring to NEC box fill table in article 370 we find the 8 #12 will fit in a 3" x 2" x 3 1/2" device box.

Box Dimension, Inches Trade Size or Type	Min. Cu. In. Cap.	Maximum Number of Conductors				
		#14	#12	#10	#8	#6
4 x 1¼ Round or Octagonal	12.5	6	5	5	4	0
4 x 1½ Round or Octagonal	15.5	7	6	6	5	0
4 x 2⅛ Round or Octagonal	21.5	10	9	8	7	0
4 x 1¼ Square	18.0	9	8	7	6	0
4 x 1½ Square	21.0	10	9	8	7	0
4 x 2⅛ Square	30.3	15	13	12	10	6*
4 11/16 x 1¼ Square	25.5	12	11	10	8	0
4 11/16 x 1½ Square	29.5	14	13	11	9	0
4 11/16 x 2⅛ Square	42.0	21	18	16	14	6
3 x 2 x 1½ Device	7.5	3	3	3	2	0
3 x 2 x 2 Device	10.0	5	4	4	3	0
3 x 2 x 2¼ Device	10.5	5	4	4	3	0
3 x 2 x 2½ Device	12.5	6	5	5	4	0
3 x 2 x 2¾ Device	14.0	7	6	5	4	0
3 x 2 x 3½ Device	18.0	9	8	7	6	0
4 x 2⅛ x 1½ Device	10.3	5	4	4	3	0
4 x 2⅛ x 1⅞ Device	13.0	6	5	5	4	0
4 x 2⅛ x 2⅛ Device	14.5	7	6	5	4	0
3¾ x 2 x 2½ Masonry Box/gang	14.0	7	6	5	4	0
3¾ x 2 x 3½ Masonry Box/gang	21.0	10	9	8	7	0
FS — Minimum Internal Depth 1¾ Single Cover/Gang	13.5	6	6	5	4	0
FD — Minimum Internal Depth 2⅜ Single Cover/Gang	18.0	9	8	7	6	3
FS — Minimum Internal Depth 1¾ Multiple Cover/Gang	18.0	9	8	7	6	0
FD — Minimum Internal Depth 2⅜ Multiple Cover/Gang	24.0	12	10	9	8	4

Answer: A 3" x 2" x 3 1/2" device box

Problems:

Box Type	Conductors	Grounding conductors	Straps	Clamps or hickeys	Total
A. Device	5#12	2#12	1	2	
B. Device	2#14	1#14	1	2	
C. Octagonal	7#14	2#14	0	2	
D. Octagonal	8#14	3#14	0	2	
E. Square	10#12	4#12	0	2	
F. Square	6#12	2#12	0	2	

ASSIGNMENT SHEET #1

	Answers		Total conductors	
A.	__________	Device box	__________	#12
B.	__________	Device box	__________	#14
C.	__________	Octagonal box	__________	#14
D.	__________	Octagonal box	__________	#14
E.	__________	Square box	__________	#12
F.	__________	Square box	__________	#12

SWITCHING SITUATIONS
UNIT III

ANSWERS TO ASSIGNMENT SHEET

A.	3" x 2" x 3 1/2" device box	8 #12
B.	3 x 2 x 2 or 3 x 2 x 2 1/4 or 4 x 2 1/8 x 1 1/2 device box	5 #14
C.	4 x 2 1/8 octagonal box	9 #14
D.	4 x 2 1/8 octagonal box	10 #14
E.	4 11/16 x 1 1/2" or 4 x 2 1/8 square box	12 #12
F.	4 x 1 1/4" square box	8 #12

SWITCHING SITUATIONS
UNIT III

JOB SHEET #1--WIRE A SINGLE POLE SWITCH CONTROLLING A SINGLE LIGHTING OUTLET WITH THE SUPPLY LINE ENTERING THE SWITCH BOX

I. Tools and equipment

A. 12-2-G or 14-2-G NM cable

B. Device box

C. Octagon box

(NOTE: Be sure your boxes have an NEC capacity rating to accomodate the conductors you will install.)

D. Staples

E. Single pole switch

F. Light socket

G. Bar hanger

(NOTE: If a bracket octagon box is used or if this job is installed on a work board, a bar hanger will not be needed.)

H. Stud wall or work board

I. 120v supply

(NOTE: The overcurrent supply should not exceed your conductors NEC ampacity rating.)

J. 3/8" cable clamp

(NOTE: This fits a one-half inch knockout.)

K. 120v incandescent bulb

L. Wire connectors

(NOTE: Twist on connectors will be used in this manual for illustrations. Wire connectors, pressure connectors or solder would also be acceptable in the trade.)

M. Two 16 penny nails

N. 2 plasterboard nails

JOB SHEET #1

O. Electrician's hammer

P. Long nose pliers

Q. Pocket knife

R. Wire strippers

S. Tool pouch

T. Drill motor or brace

U. 1/2" or larger wood bit

(NOTE: Hole should be large enough to safely accomodate cable.)

V. Extension cord

W. Safety glasses

X. Portable GFI

II. Procedure

A. Put on safety glasses and gather tools and equipment

B. Mount boxes (Figure 1)

(NOTE: Switch box and ceiling outlet can be mounted at any height in this project.)

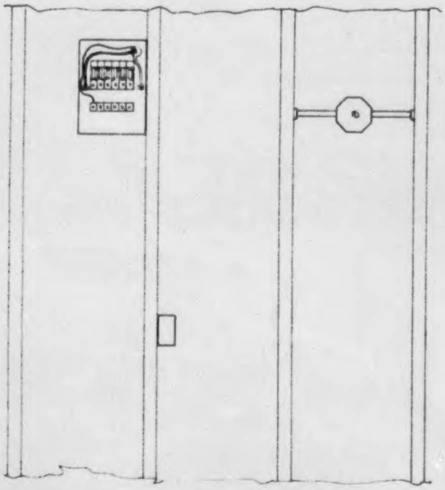


FIGURE 1

JOB SHEET #1

C. Remove a half inch knockout from the panel

1. Locate 1/2" KO (knockout) to be removed
2. Place screwdriver on KO at point opposite unstamped piece (Figure 2)

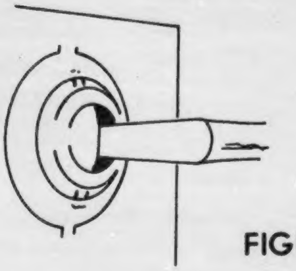


FIGURE 2

3. Hit screwdriver handle crisply with hammer (Figure 3)

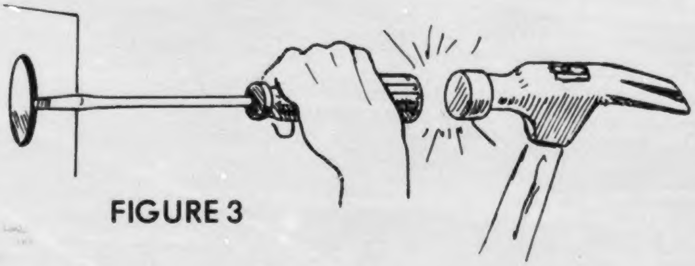


FIGURE 3

4. Grasp raised KO with lineman's pliers
5. Bend KO back and forth until removed (Figure 4

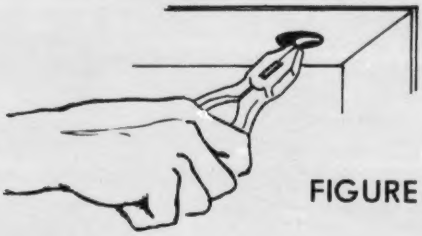


FIGURE 4

JOB SHEET #1

D. Install cable connector

1. Hold connector and unscrew locknut (Figure 5)

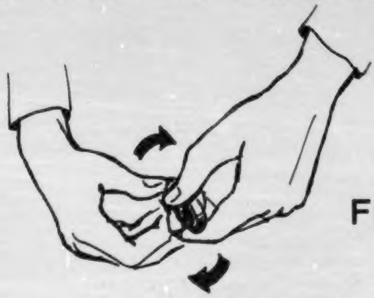


FIGURE 5

2. Place threads through KO opening (Figure 6)

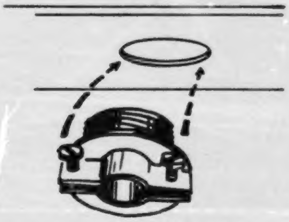


FIGURE 6

3. Install locknut (Figure 7)

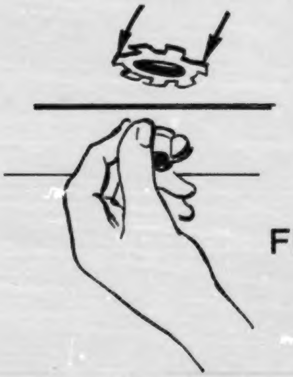
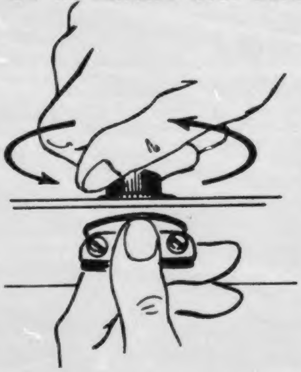


FIGURE 7

4. Tighten locknut (Figure 8)

(NOTE: Be sure serrated teeth are in contact with box.)

FIGURE 8



JOB SHEET #1

5. Tighten locknut securely (Figure 9)

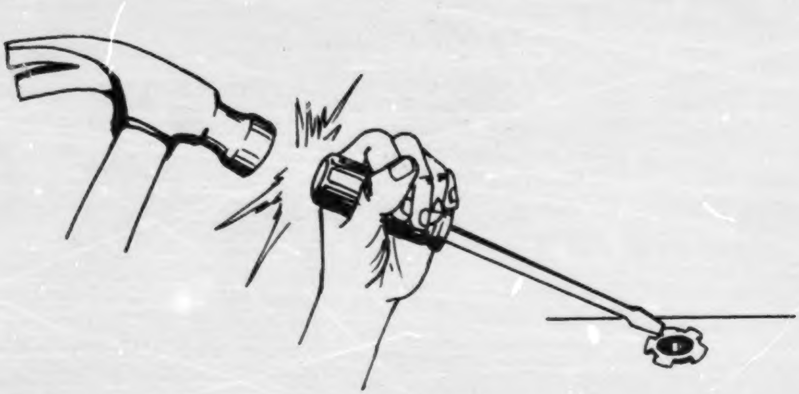


FIGURE 9

E. Plug cord into portable GFI

F. Bore holes for cable

(NOTE: Holes should be drilled as close to the center (front to back) of a stud as possible. Holes should be drilled at least 6 inches above or below box depending on which route is the closest.)

(CAUTION: Be sure and hold the drill securely. A loose grip can cause an accident.)

JOB SHEET #1

G. Run cable

1. Remove KO's from boxes

   a. Place screwdriver in slot (Figure 10)

      (NOTE: This is for metal boxes; most plastic boxes have KOs that are broken out by placing a screwdriver in the center and hitting with your hand or hammer.)

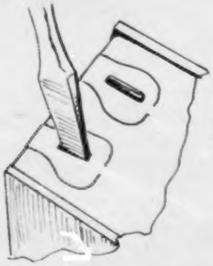


FIGURE 10

   b. Pry KO out (Figure 11)

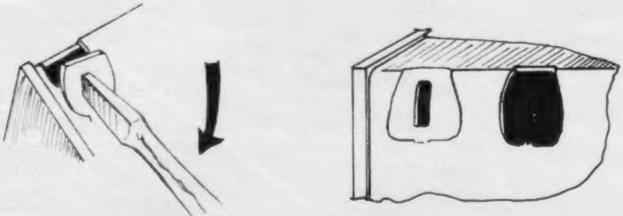


FIGURE 11

   c. Wiggle screwdriver until KO pops loose (Figure 12)

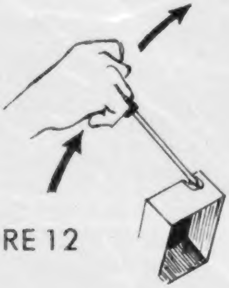


FIGURE 12

JOB SHEET #1

2. Run cable between boxes (Figure 13)

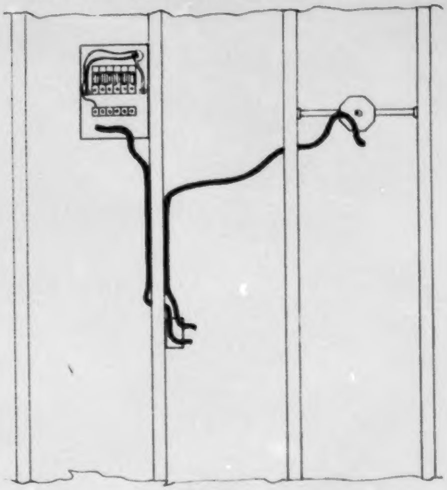


FIGURE 13

(NOTE: Leave at least 8" extending past the surface of your device and lighting outlet boxes, and enough to reach the top of your panel plus 1/2 of the width.)

H. Staple cable within 12" of all metal boxes, 8" of all nonmetallic boxes

(NOTE: Cables should be run flat when possible.)

I. Secure all cable clamps and connectors

(CAUTION: Tighten them until the cable will not slip in the box; overtightening can cause an electrical short.)

J. Strip cable insulation (Figure 14)

(NOTE: Cables could be stripped before they are installed in the boxes.)

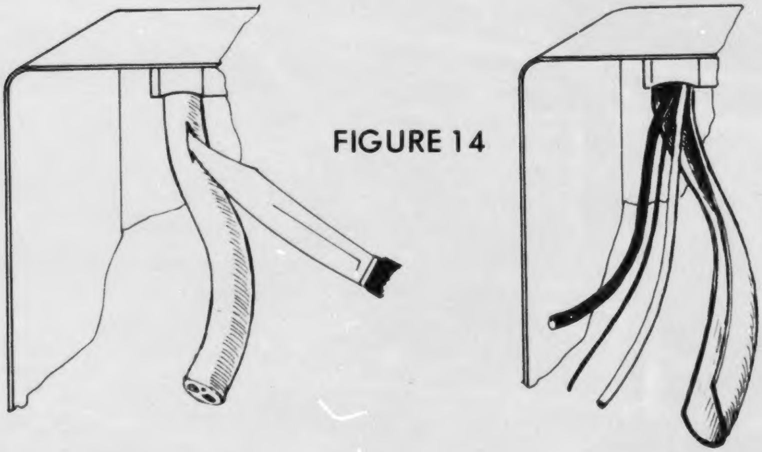


FIGURE 14

JOB SHEET #1

(NOTE: Trim the cable covering to within 1/4" of its point of entry.)

(CAUTION: Extreme care should always be used in operations involving the knife; a cut hand can cause pain and lost work time.)

K. Connect all grounding conductors (green or bare) (Figure 15)

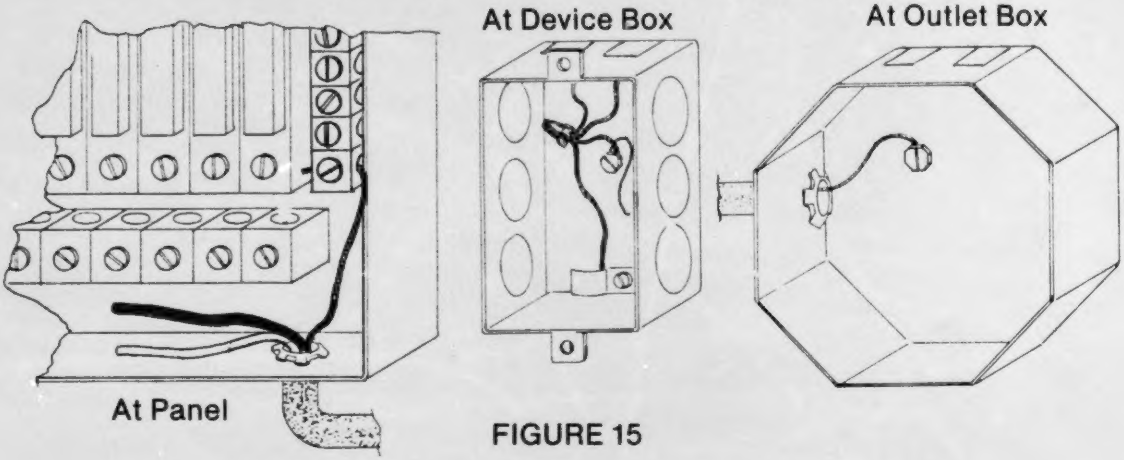

At Device Box
At Outlet Box
At Panel

FIGURE 15

(NOTE: Always leave enough conductor to make removal and connection easy. Notice extra bend at panel.)

L. Connect all neutral conductors (white or natural gray) (Figure 16)

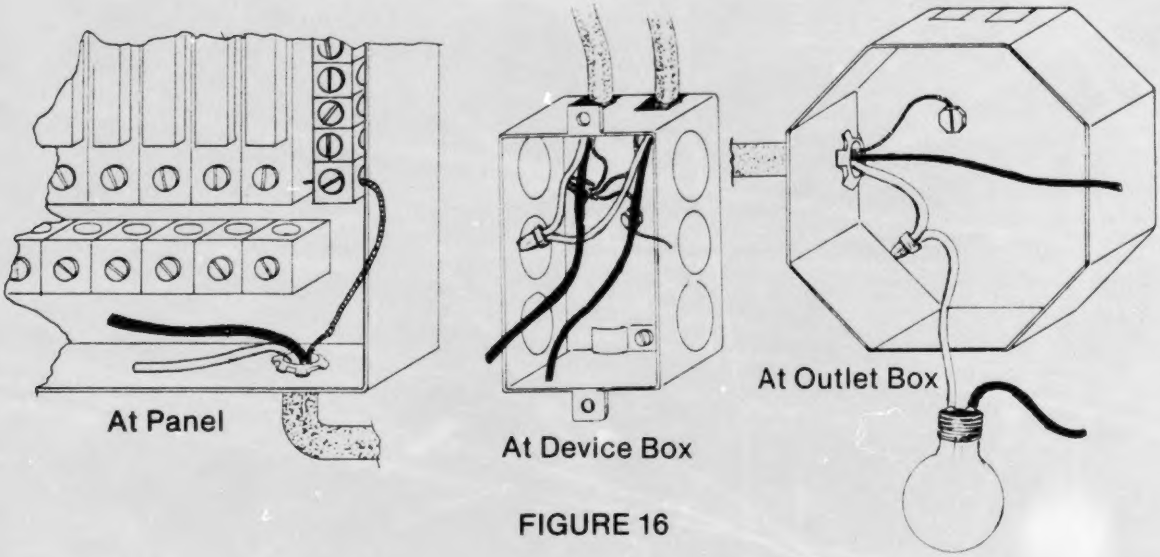

At Outlet Box
At Panel
At Device Box

FIGURE 16

M. Connect return leg to remaining lampholder, conductor, or terminal

JOB SHEET #1

N. Connect switch (Figure 17)

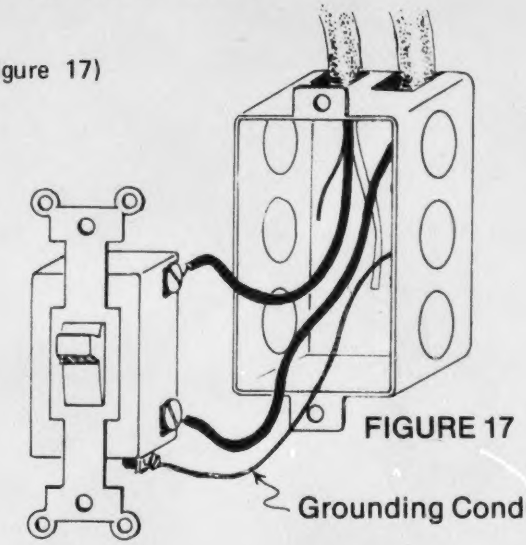


FIGURE 17

(NOTE: Be sure that the loop in the conductors is turned in the direction that the terminal tightens.)

O. Install the switch in box

(NOTE: Be sure and push all conductors into the box; don't rely on the installation of the switch to situate them.)

P. Connect ungrounded conductor to appropriate overcurrent device (Figure 18)

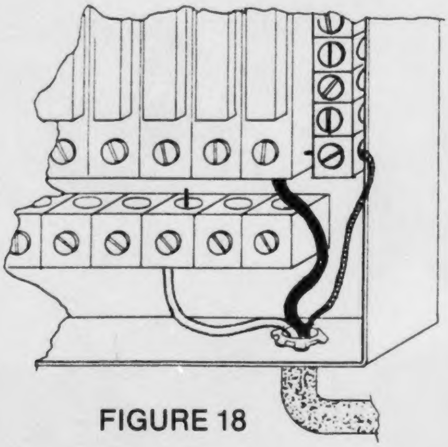


FIGURE 18

(NOTE: Be sure the breaker is off or the fuse is out before connecting this conductor. Always be safety conscious when working inside a panel.)

JOB SHEET #1

Q. Put single pole in off position

R. Turn breaker on

(CAUTION: Stand to the side of the panel when turning on the breaker. A short in the circuit could cause molten metal to fly from the panel.)

S. Turn on the switch

T. Have your instructor evaluate this project

U. Turn off breaker

SWITCHING SITUATIONS
UNIT III

JOB SHEET #2--WIRE A SINGLE POLE SWITCH CONTROLLING A SINGLE LIGHTING OUTLET WITH THE SUPPLY LINE ENTERING THE LIGHTING OUTLET BOX

I. Tools and equipment

   A. 12-2-G or 14-2-G NM cable

   B. Device box

   C. Octagon box

   (NOTE: Be sure your boxes have an NEC capacity rating to accomodate the conductors you will install.)

   D. Staples

   E. Single pole switch

   F. Light socket

   G. Bar hanger

   (NOTE: If a bracket octagon box is used, or if this job is installed on a work board, a bar hanger will not be needed.)

   H. Stud wall or work board

   I. 120v supply

   (NOTE: The overcurrent supply should not exceed your conductors NEC ampacity rating.)

   J. 3/8" cable clamp

   K. 120v incandescent bulb

   L. Wire connectors

   (NOTE: Twist on connectors will be used in this manual for illustrations. Wire connectors, pressure connectors or solder would also be acceptable in the trade.)

   M. Two 16 penny nails

   N. 2 plasterboard nails

   O. Electrician's hammer

JOB SHEET #2

P. Plain tip screwdriver

Q. Lineman's pliers

R. Long nose pliers

S. Pocket knife

T. Wire strippers

U. Tool pouch

V. Drill motor or brace

W. 1/2" or larger wood bit

(NOTE: Hole should be large enough to safely accomodate cable.)

X. Extension cord

Y. Safety glasses

Z. Portable GFI

II. Procedure

A. Put on safety glasses and gather tools and equipment

B. Mount boxes

(NOTE: Switch box and ceiling outlet can be mounted at any height in this project.)

C. Remove a half inch knockout from the panel

D. Install cable connector

E. Plug cord into portable GFI

F. Bore holes for cable

(NOTE: Holes should be drilled as close to the center (front to back) of a stud as possible. Holes should be drilled at least 6 inches above or below box depending on which route is the closest.)

(CAUTION: Be sure and hold the drill securely. A loose grip can cause an accident.)

JOB SHEET #2

G. Run cable (Figure 1)

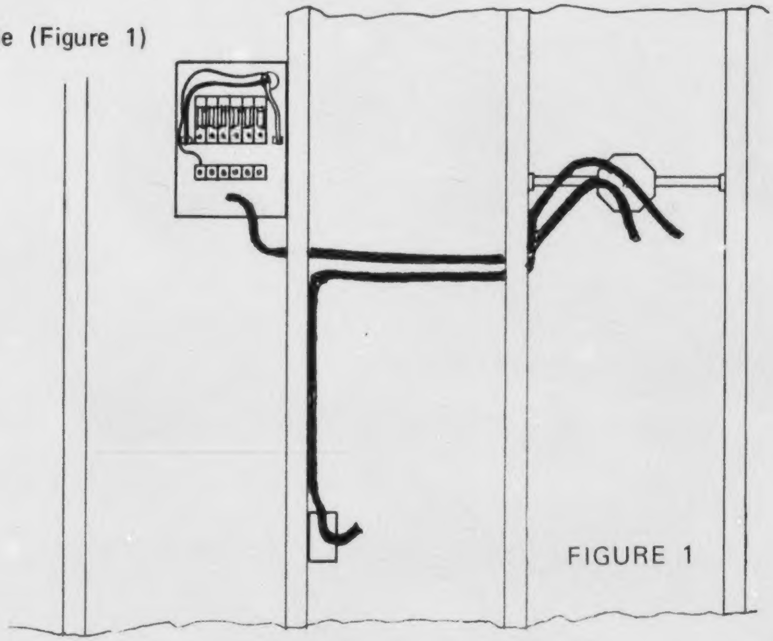


FIGURE 1

(NOTE: Leave at least 8" extending past the surface of your device and lighting outlet boxes, and enough to reach the top of your panel plus half the width. The cable from the switch should enter the outlet box through the hole closest to the switch for later identification.)

H. Staple cable within 12" of all metal boxes, 8" of all nonmetallic boxes

I. Secure all cable clamps and connectors

(CAUTION: Tighten them until the cable will not slip in the box, overtightening can cause an electrical short.)

J. Strip cable insulation

(NOTE: Trim the cable covering to within 1/4" of its point of entry.)

(CAUTION: Extreme care should always be used in operations involving the knife; a cut hand can cause pain and lost work time.)

JOB SHEET #2

K. Connect all grounding conductors (green or bare) (Figure 2)

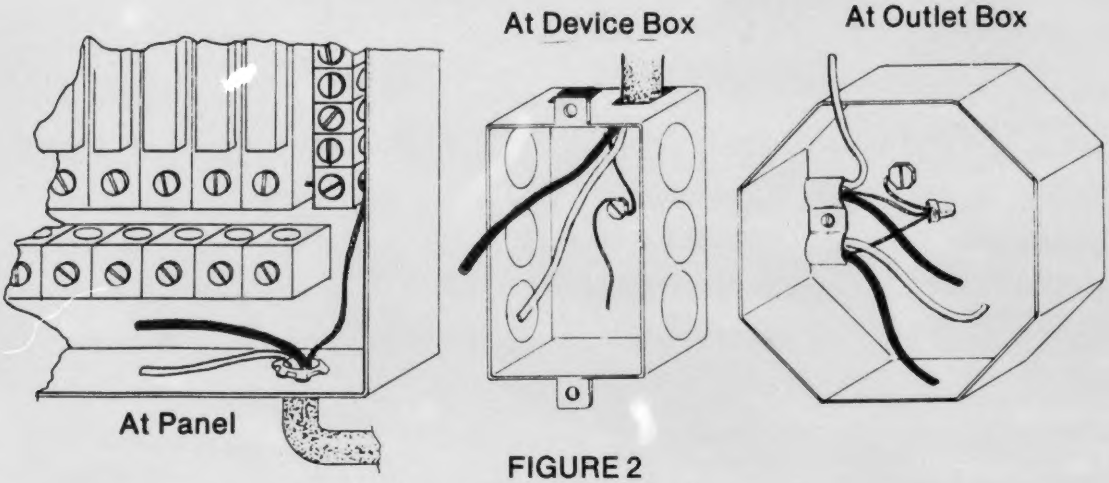

At Device Box
At Outlet Box
At Panel

FIGURE 2

(NOTE: Always leave enough conductor to make removal and reconnection easy. Notice extra bend at panel.)

L. Connect all neutral conductors (white or natural gray) (Figure 3)

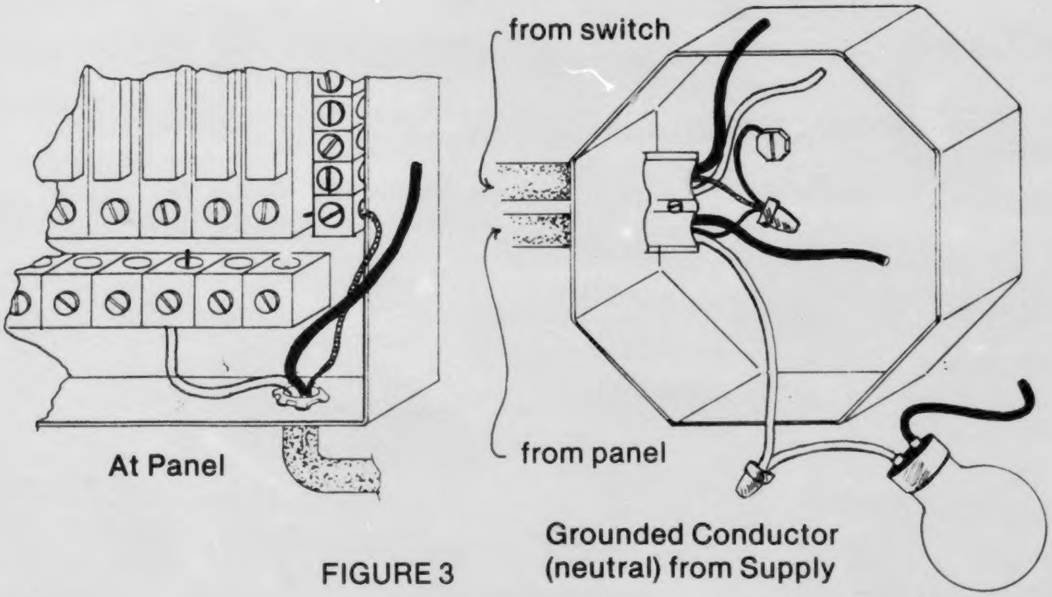

from switch
from panel
At Panel
Grounded Conductor
(neutral) from Supply

FIGURE 3

(NOTE: The grounded conductor in this circuit goes from the grounded terminal of the panel to the light and stops.)

JOB SHEET #2

M. Make up outlet box (Figure 4)

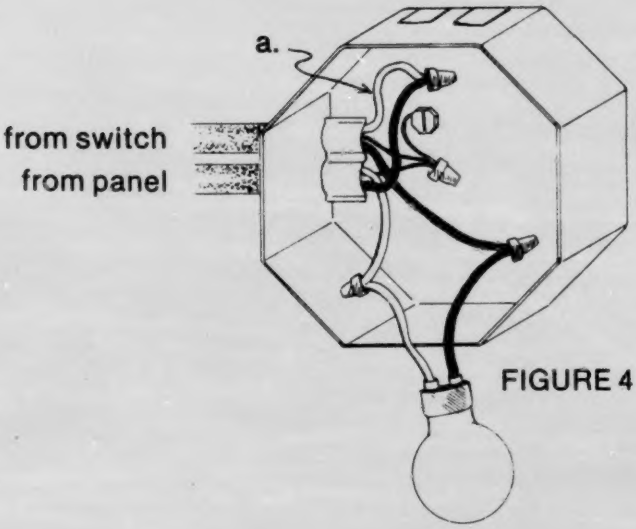


FIGURE 4

(NOTE: In switching situations you are allowed to use the white or gray conductor as the switch leg (a).)

N. Install conductors on switch

(NOTE: It makes no difference which terminals the white and black conductors go on. The grounding however must go on the green, hex headed screw.)

O. Install switch in box

P. Connect ungrounded conductor to appropriate overcurrent protection (Figure 5)

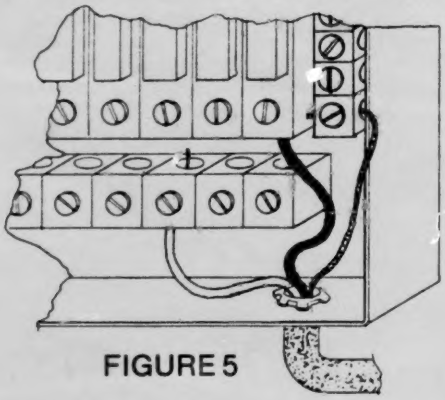


FIGURE 5

(CAUTION: Be sure the breaker is off or the fuse is out before connecting this conductor. Always be safety conscious.)

JOB SHEET #2

Q. Put switch in off position

R. Turn breaker on

(CAUTION: Stand to the side of the panel when turning on the breaker. A short in the circuit could cause molten metal to fly from the panel.)

S. Turn on the switch

T. Have your instructor evaluate this project

U. Turn off breaker

SWITCHING SITUATIONS
UNIT III

JOB SHEET #3--WIRE A THREE WAY SWITCHING SITUATION WITH THE SUPPLY ENTERING A SINGLE LIGHTING OUTLET

I. Tools and equipment

A. 12-2-G or 14-2-G and 12-3-G or 14-3G NM cable

B. Two device boxes

C. Octagon box

(NOTE: Be sure your boxes have an NEC capacity rating to accomodate the conductors you will install.)

D. Staples

E. Two 3 way switches

F. Light socket

G. Bar hanger

(NOTE: If a bracket octagon box is used or if this job is installed on a work board, a bar hanger will not be needed.)

H. Stud wall or work board

I. 120v supply

(NOTE: The overcurrent supply should not exceed your conductors NEC ampacity rating.)

J. 3/8" cable clamp

K. 120v incandescent bulb

L. Wire connectors

(NOTE: Twist on connectors will be used in this manual for illustrations. Wire connectors, pressure connectors, or solder would also be acceptable in the trade.)

M. Two 16 penny nails

N. 2 plasterboard nails

O. Electrician's hammer

JOB SHEET #3

P. Plain tip screwdriver

Q. Lineman's pliers

R. Needle nose pliers

S. Pocket knife

T. Wire strippers

U. Tool pouch

V. Drill motor or brace

W. 1/2" or larger wood bit

(NOTE: Holes should be large enough to safely accomodate the cables.)

X. Extension cord

Y. Safety glasses

Z. Portable GFI

II. Procedure

A. Gather tools and equipment

B. Mount boxes (Figure 1)

(NOTE: Switch box and ceiling outlet can be mounted at any height in this project.)

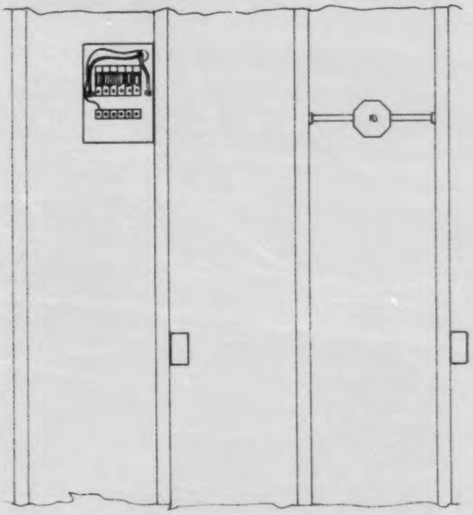


FIGURE 1

JOB SHEET #3

C. Remove a half inch knockout from the panel

D. Install cable connector

E. Plug cord into GFI

F. Bore holes for cable

(NOTE: Holes should be drilled as close to the center (front to back) of a stud as possible. Holes should be drilled at least 6 inches above or below box depending on which route is the closest.)

(CAUTION: Be sure and hold the drill securely. A loose grip can cause an accident.)

G. Run cable (Figure 2)

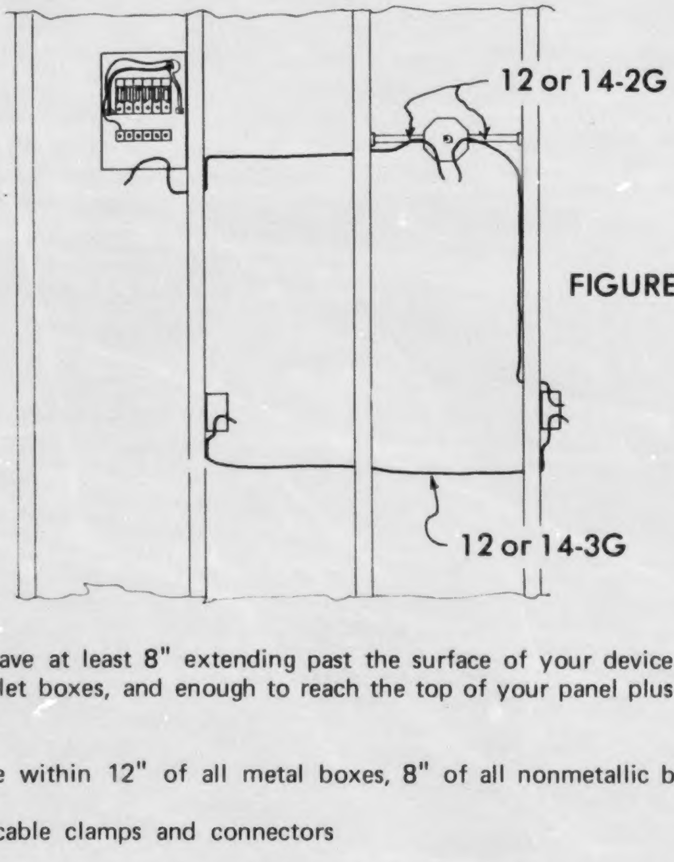


FIGURE 2

(NOTE: Leave at least 8" extending past the surface of your device and lighting outlet boxes, and enough to reach the top of your panel plus half the width.)

H. Staple cable within 12" of all metal boxes, 8" of all nonmetallic boxes

I. Secure all cable clamps and connectors

(CAUTION: Tighten them until the cable will not slip in the box; overtightening can cause an electrical short.)

JOB SHEET #3

J. Strip cable insulation (Figure 3)

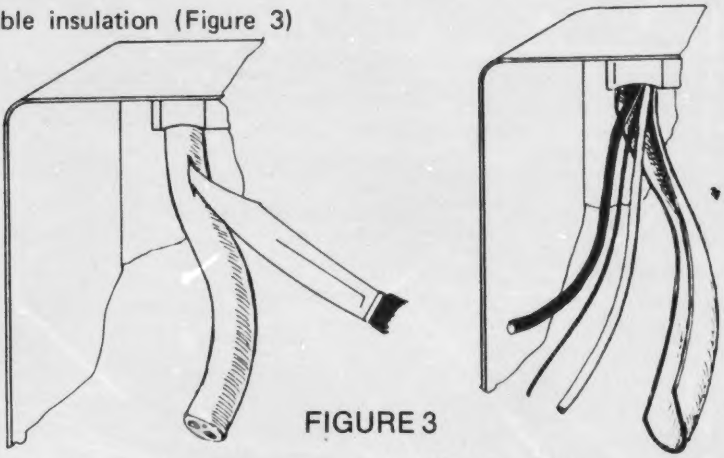


FIGURE 3

(NOTE: Trim the cable covering to within 1/4" of its point of entry.)

(CAUTION: Extreme care should always be used in operations involving the knife; a cut hand can cause pain and lost work time.)

K. Connect all grounding conductors (Figure 4)

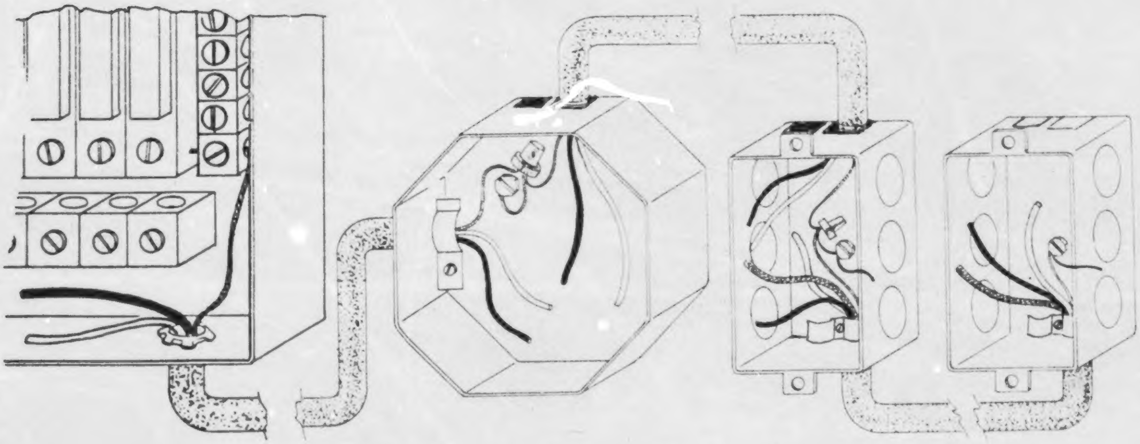


FIGURE 4

JOB SHEET #3

L. Connect neutral conductors (Figure 5)

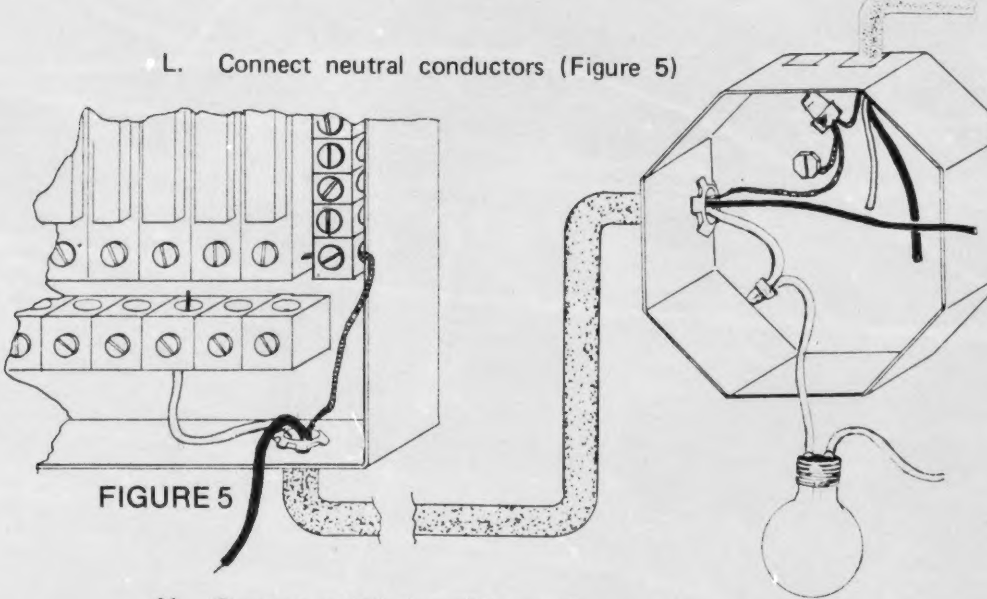


FIGURE 5

M. Connect switch legs (Figure 6)

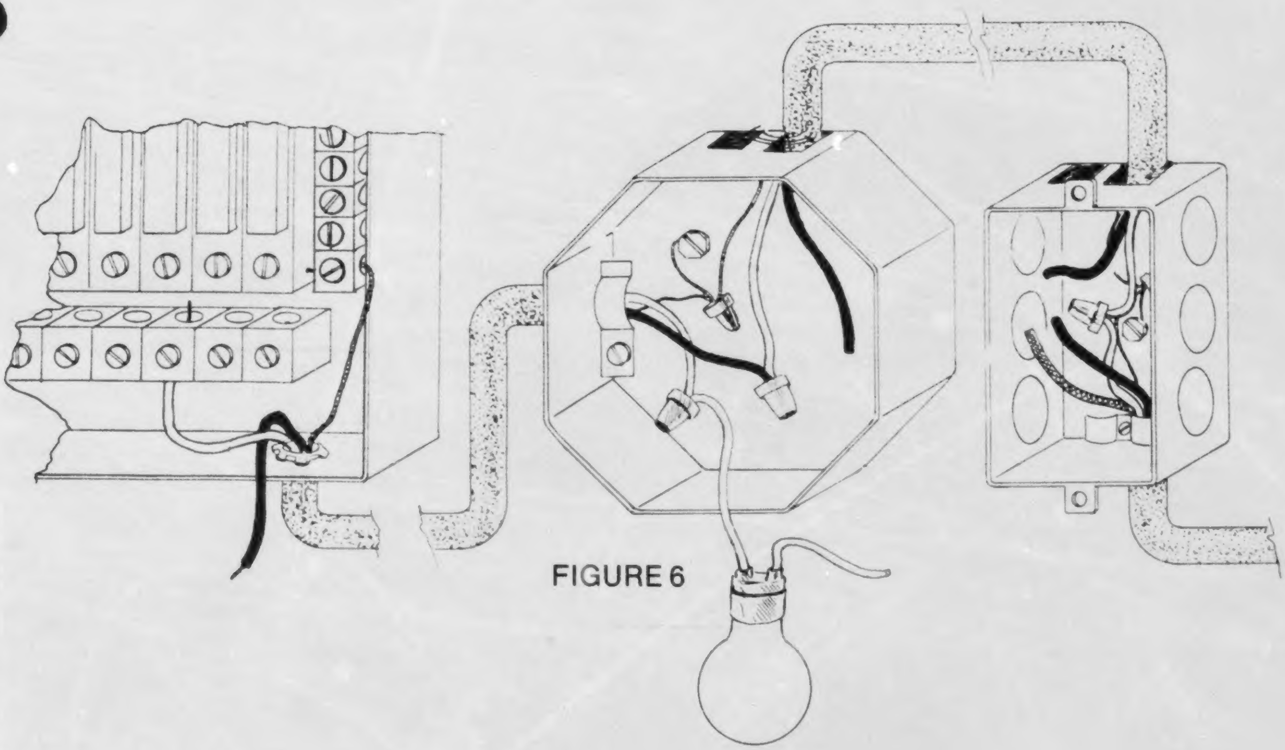


FIGURE 6

JOB SHEET #3

N. Install switches (Figure 7)

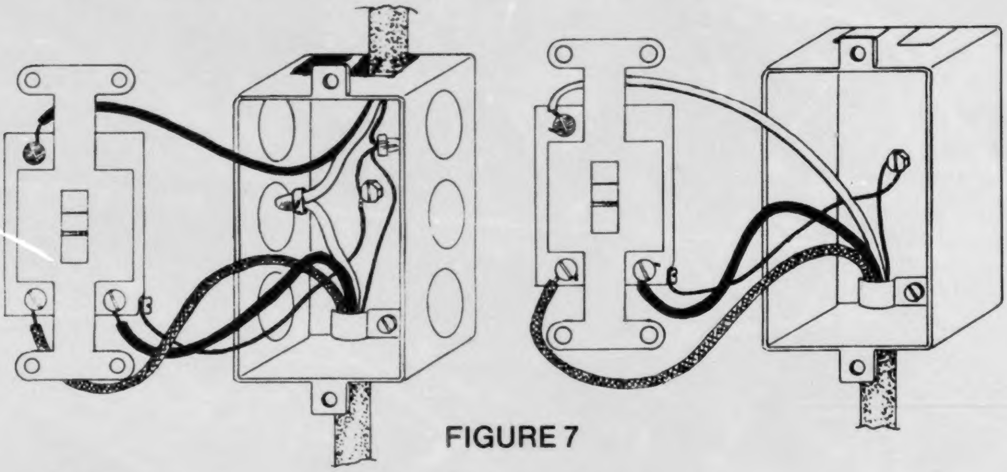


FIGURE 7

(NOTE: In all three way circuits the switch leg goes on one common screw and the return leg goes on the other with travelers connecting to the remaining screws on each device. The grounding screw attaches to the green hex headed screw on the strap.)

O. Connect return leg to socket

P. Connect ungrounded conductor to appropriate overcurrent device (Figure 8)

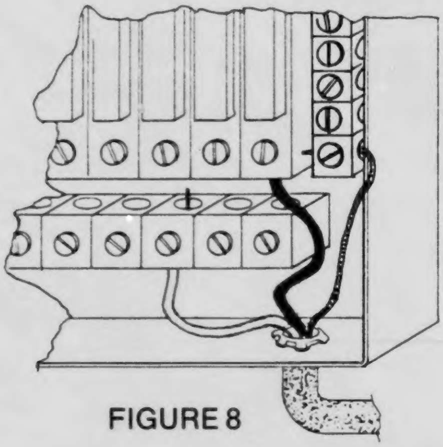


FIGURE 8

(CAUTION: Be sure the breaker is off or the fuse is out before connecting this conductor. Always be safety conscious.)

JOB SHEET #3

Q. Turn breaker on

(CAUTION: Stand to the side of the panel when turning on the breaker. A short in the circuit could cause molten metal to fly from the panel.)

R. Change the position of the switches in alternating movements

(NOTE: Be sure you can turn the light on or off from either switch as well as on at one and off at the other.)

S. Have instructor evaluate this project

T. Turn off breaker

SWITCHING SITUATIONS
UNIT III

JOB SHEET #4--WIRE A FOUR WAY SWITCHING SITUATION WITH THE SUPPLY ENTERING THE LIGHTING OUTLET BOX

I. Tools and equipment

A. 12-2-G or 14-2-G and
12-3-G or 14-3-G NM cable

B. 3 device boxes

C. Octagon box

(NOTE: Be sure your boxes have an NEC capacity rating to accomodate the conductors you will install.)

D. Staples

E. Two 3 way switches

F. One 4 way switch

G. Light socket

H. Bar hanger

(NOTE: If a bracket octagon box is used or if this job is installed on a work board, a bar hanger will not be needed.)

I. Stud wall or work board

J. 120v supply

(NOTE: The overcurrent supply should not exceed your conductor's NEC ampacity rating.)

K. 3/8" cable clamp

L. 120v incandescent bulb

M. Wire connectors

(NOTE: Twist on connectors will be used in this manual for illustrations. Wire connectors, pressure connectors, or solder would also be acceptable in the trade.)

N. Two 16 penny nails

O. Two plasterboard nails

JOB SHEET #4

P. Electrician's hammer

Q. Plain tip screwdriver

R. Lineman's pliers

S. Long nose pliers

T. Pocket knife

U. Wire strippers

V. Tool pouch

W. Drill motor or brace

X. 1/2" or larger wood bit

(NOTE: Holes should be large enough to safely accomodate cables.)

Y. Extension cord

Z. Safety glasses

AA. Portable GFI

II. Procedure

A. Put on safety glasses and gather tools and equipment

B. Mount boxes (Figure 1)

(NOTE: Switch box and ceiling outlet can be mounted at any height in this project.)

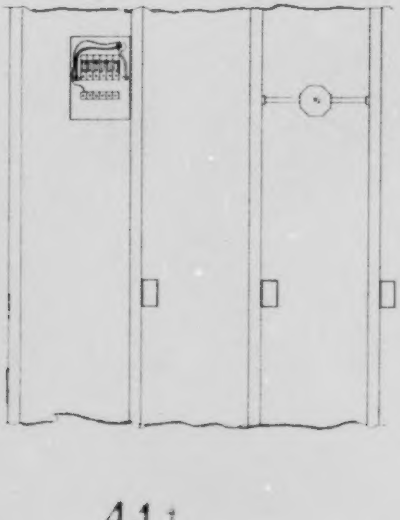


FIGURE 1

JOB SHEET #4

C. Remove a half inch knockout from the panel

D. Install cable connector

E. Plug cord into GFI

F. Bore holes for cable

(NOTE: Holes should be drilled as close to the center (front to back) of a stud as possible. Holes should be drilled at least 6 inches above or below box depending on which route is the closest.)

(CAUTION: Be sure and hold the drill securely. A loose grip can cause an accident.)

G. Run cable (Figure 2)

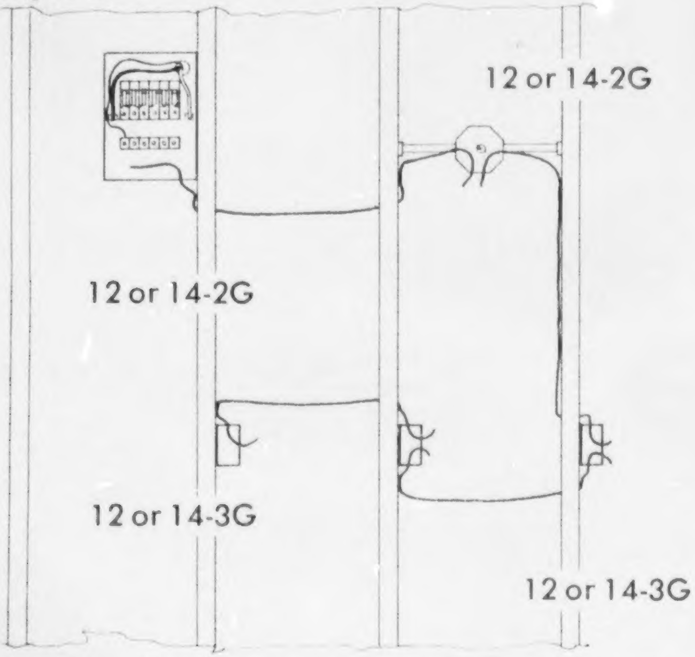


FIGURE 2

(NOTE: Leave at least 8" extending past the surface of your device and lighting outlet boxes, and enough to reach the top of your panel plus half the width.)

H. Staple cable within 12" of all metal boxes, 8" of all nonmetallic boxes

I. Secure all cable clamps and connectors

(CAUTION: Tighten them until the cable will not slip in the box; overtightening can cause an electrical short.)

JOB SHEET #4

J. Strip cable insulation

(NOTE: Trim the cable covering to within 1/4" of its point of entry.)

(CAUTION: Extreme care should always be used in operations involving the knife; a cut hand can cause pain and lost work time.)

K. Connect all grounding conductors (Figure 3)

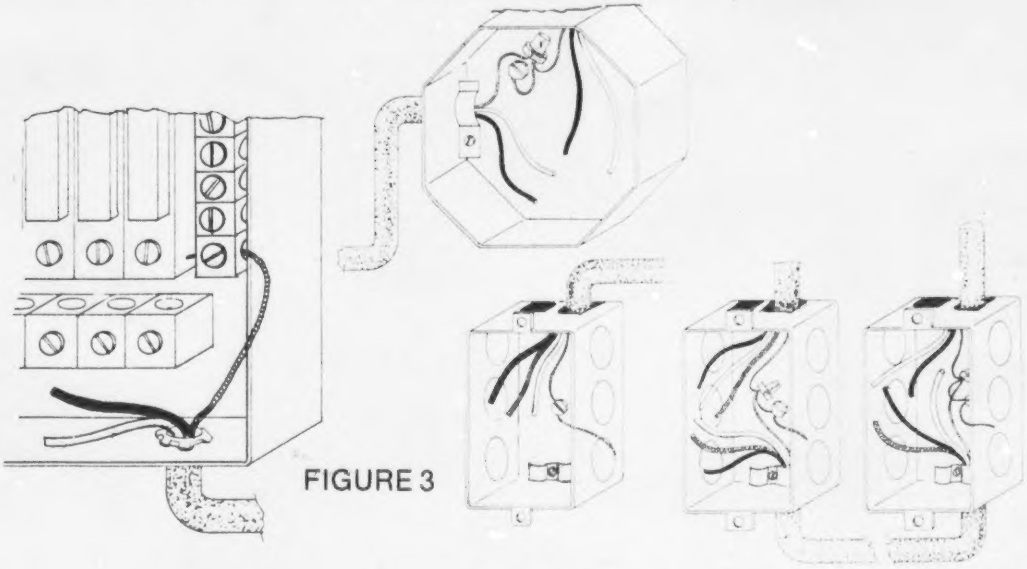


FIGURE 3

(NOTE: Always leave enough conductor to make removal and reconnection easy. Notice extra bend at panel.)

L. Connect all neutral conductors (Figure 4)

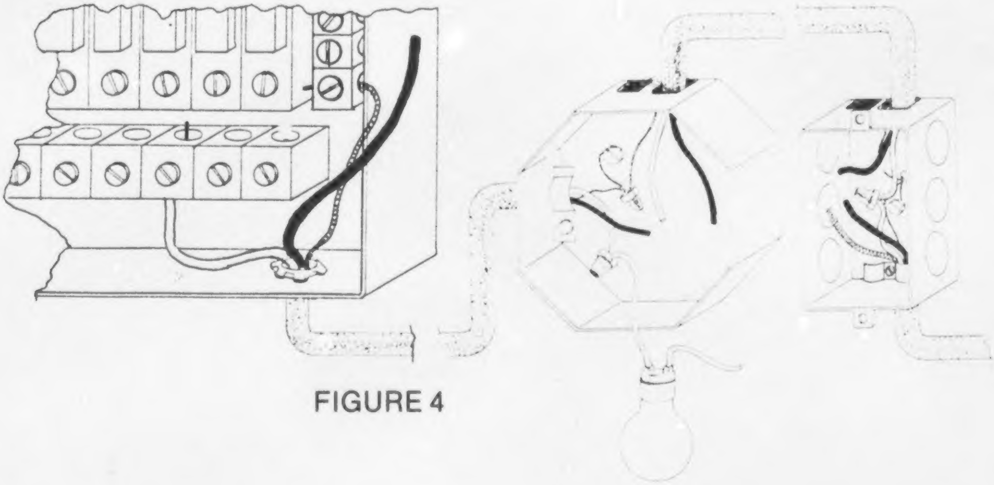


FIGURE 4

JOB SHEET #4

M. Connect switch leg through the system (Figure 5)

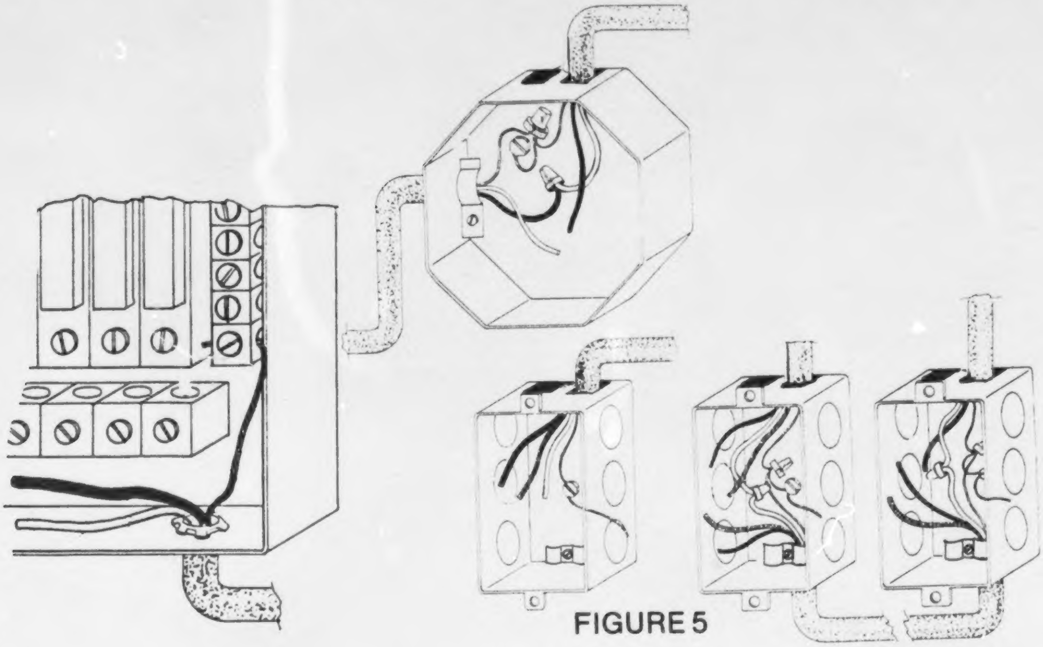


FIGURE 5

N. Install switches (Figure 6)

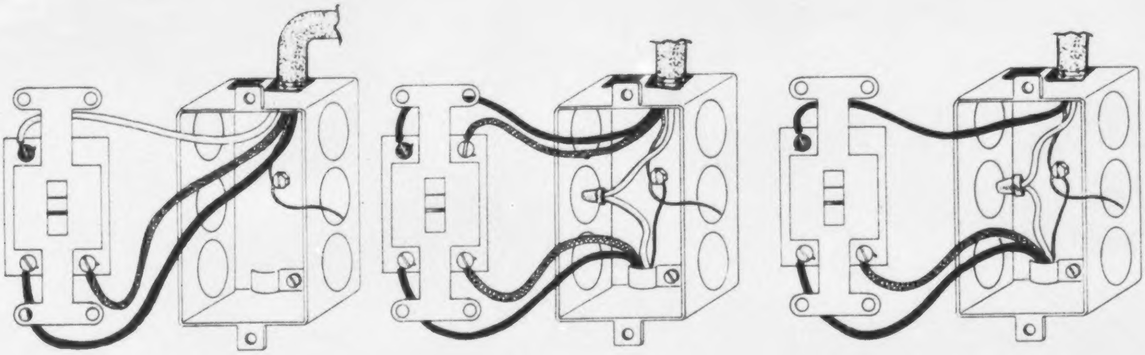


FIGURE 6

O. Connect return leg to socket

JOB SHEET #4

P. Connect ungrounded conductor to appropriate overcurrent device (Figure 7)

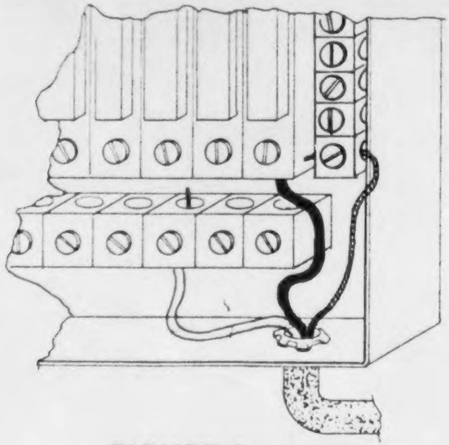


FIGURE 7

(CAUTION: Be sure the breaker is off or the fuse is out before connecting this conductor. Always be safety conscious.)

Q. Turn breaker on

(CAUTION: Stand to the side of the panel when turning on the breaker. A short in the circuit could cause molten metal to fly from the panel.)

R. Change the position of the switches in alternating movements

(NOTE: Be sure you can turn the light on or off from switch as well as on at one end and off at the other.)

S. Have your instructor evaluate this project

T. Turn off breaker

SWITCHING SITUATIONS
UNIT III

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Point of attachment for conductors

_____b. Piece of equipment used to secure cables

_____c. Unit of an electrical system which is intended to carry but not utilize electrical energy

_____d. Metal strip which contains one or more devices

_____e. Threaded nipple used for hanging fixtures

_____f. Device used to open or transfer circuit direction

_____g. Conductor that supplies electrical energy to a switch

_____h. Conductor that carries electrical energy from the switch to the load

_____i. Transfer conductors in a switching situation; they are used between 3-ways and 4-ways

_____j. Conductors between light and switch when supply enters the light

1. Switch
2. Traveler
3. Cable clamp
4. Hickey
5. Device
6. Terminal
7. Strap
8. Switch leg
9. Return leg
10. Switch loop

2. List the six steps for determining appropriate box size.

a.

b.

c.

d.

e.

f.

3. List the four requirements for terminal identification.

a.

b.

c.

d.

4. List the five steps for grounding devices and boxes.

a.

b.

c.

d.

e.

5. Identify the parts of the following switching circuits.

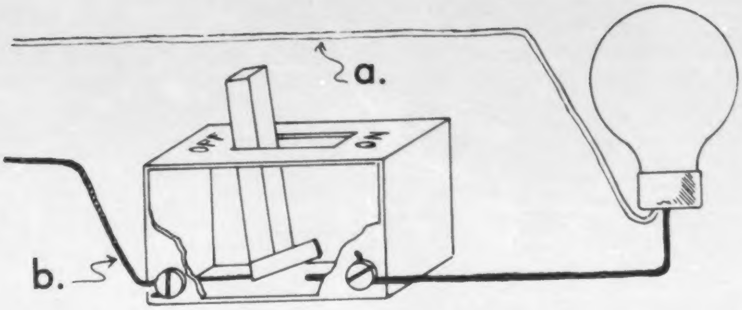
a.

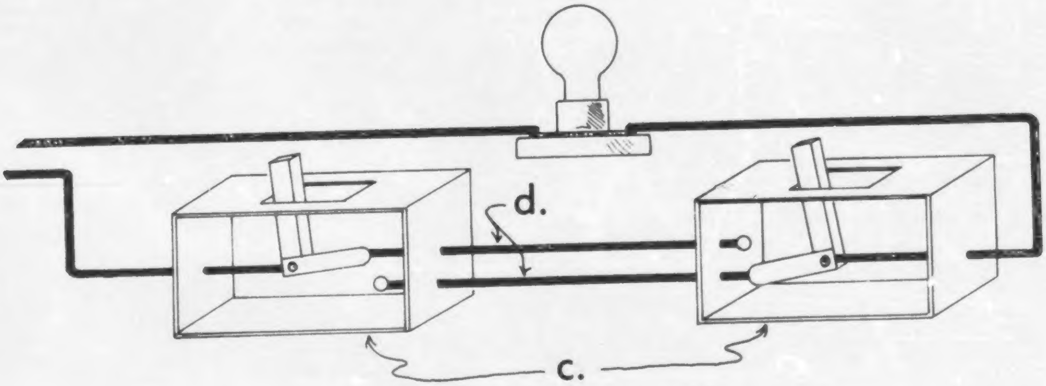
b.

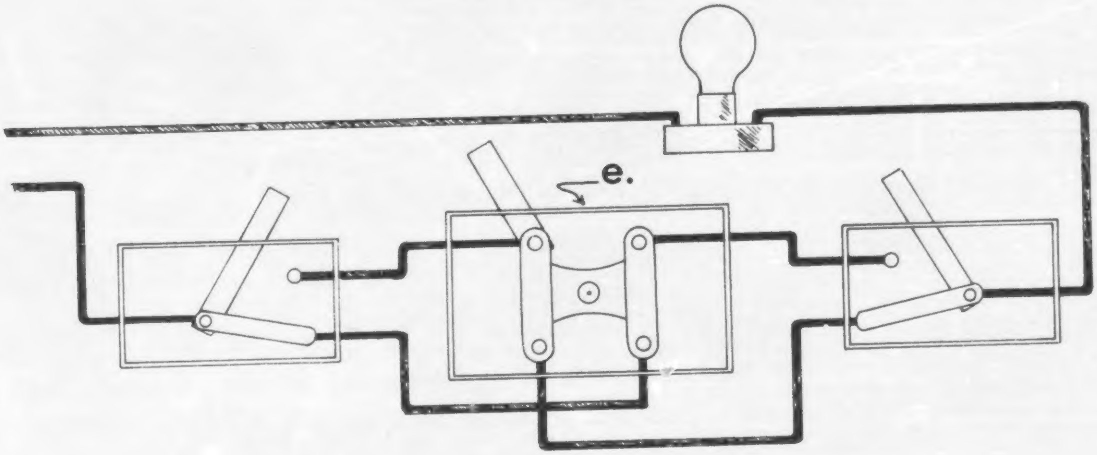
c.

d.

e.


a.
OFF
ON
b.


d.
c.


e.

6. Determine metal box size when given the number and size of conductors to be installed.

7. Demonstrate the ability to:

    a. Wire a single pole switch controlling a single lighting outlet with the supply line entering the switch box.

    b. Wire a single pole switch controlling a single lighting outlet with the supply line entering the lighting outlet.

    c. Wire a three way switching situation with the supply entering a single lighting outlet.

    d. Wire a four way switching situation with the supply entering the lighting outlet box.

    (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

SWITCHING SITUATIONS
UNIT III

ANSWERS TO TEST

1.	a.	6	f.	1
	b.	3	g.	8
	c.	5	h.	9
	d.	7	i.	2
	e.	4	j.	10

2. a. Determine number of conductors (other than grounding) to be contained in the box

   b. Determine size of conductors to be used

   c. Determine if any fixture studs, cable clamps, or hickeys are to be contained in the box and count as one conductor

   d. Determine number of straps containing devices to be attached and count as one conductor per strap

   e. Determine if grounding conductor will enter box and count as one

   f. Add total A, C, D, and E and refer to NEC table in Article 370 using wire size determined in "B"

3. a. All grounding terminals shall be green and hex headed

   b. Traveler terminals on three way switches shall be the same color, and different from the controlling or common terminal

   c. Neutral conductors and terminals shall be white, silver, or labeled with the word white or letter W

   d. Ungrounded conductors--Usually copper colored but could be any color other than those already designated

4. a. Group and solidly connect all grounding conductors

   b. Connection shall be made from the grounding conductors to a green hex headed screw or other device to ground all metal boxes

   c. Grounding terminals on devices shall be connected to metal boxes by a bonding jumper on metal boxes for flush installations

   d. On surface boxes the metal to metal contact between the device and box shall serve as the grounding bond
   e. In plastic boxes group the grounding conductors and connect them to the device grounding terminal

5. a. Neutral
   b. Switch leg
   c. Three way switches
   d. Travelers
   e. Four way switch
6. Evaluated to the satisfaction of the instructor
7. Performance skills evaluated to the satisfaction of the instructor

RECEPTACLE OUTLETS
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms to their correct definitions, identify common residential receptacles, the parts of a duplex grounding type receptacle, and the parts of the equipment grounding circuit. The student should also be able to install common residential receptacles. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with receptacle outlets to the correct definitions.
2. Identify parts of a duplex grounding type receptacle.
3. Identify parts of the equipment grounding circuit.
4. List three NEC requirements pertaining to receptacles.
5. Demonstrate the ability to:
    a. Install a duplex grounding type receptacle.
    b. Install a range or dryer receptacle.
    c. Install a multi-circuit split-wired duplex grounding type receptacle.

RECEPTACLE OUTLETS
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Discuss safety and code procedures with student.

   H. Have student practice all job sheets until proficient.

   I. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Complete activities assigned by instructor.

   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Parts of a Duplex Grounding Type Receptacle

      2. TM 2--Equipment Grounding Circuit

D. Job sheets

   1. Job Sheet #1--Install a Duplex Grounding Type Receptacle

   2. Job Sheet #2--Install a Range or Dryer Receptacle

   3. Job Sheet #3--Install a Multi-Circuit Split-Wired Duplex Grounding Type Receptacle

E. Test

F. Answers to test

II. References:

A. *National Electrical Code,* 1981. Boston: National Fire Protection Association, 1980.

B. *Leviton Catalog Number D-100.* Brooklyn, New York.

RECEPTACLE OUTLETS
UNIT IV

INFORMATION SHEET

I. Terms and definitions

   A. Poles--Current carrying conductors, both grounded and ungrounded, on a receptacle

   B. Wires--Current carrying conductors and grounding conductors

   C. Strap or yoke--Metal strip containing one or more devices

   D. Single receptacle--A single contact device with no other contact device on the same yoke

   E. Multiple receptacle--A single device with two or more receptacles

   F. Duplex grounding receptacle--A single device with two grounding type receptacles

II. Parts of a duplex grounding type receptacle (Transparency 1)

   A. Strap or yoke

   B. Mounting screws

   C. Ungrounded terminal

   D. Ungrounded contact slot

   E. Grounded contact slot

   F. Break off fin

   G. Grounding contact slot

   H. Grounded terminals

   I. Grounding terminal

III. Parts of equipment grounding circuit (Transparency 2)

   A. Grounding conductor

   B. Neutral block or bus bar

   C. Attachment cap grounding prong

   D. Receptacle grounding slot

   E. Grounding connection at appliance frame

INFORMATION SHEET

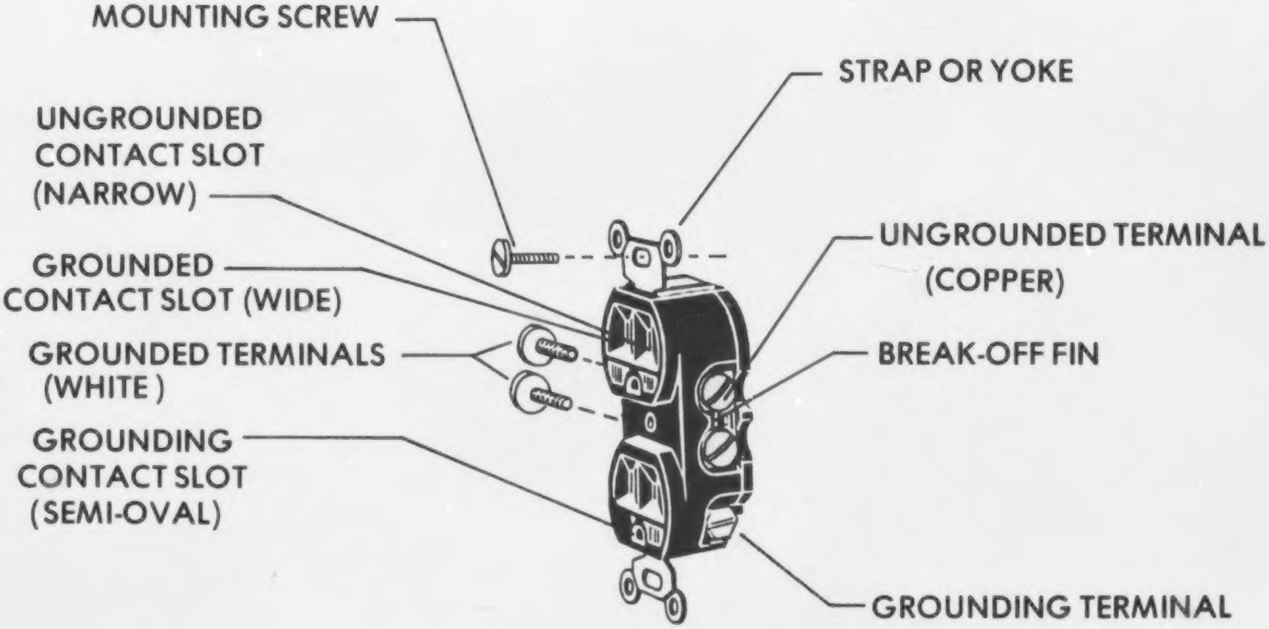
- F. Grounding electrode conductor
- G. Grounding electrode

IV. NEC requirements pertaining to receptacles

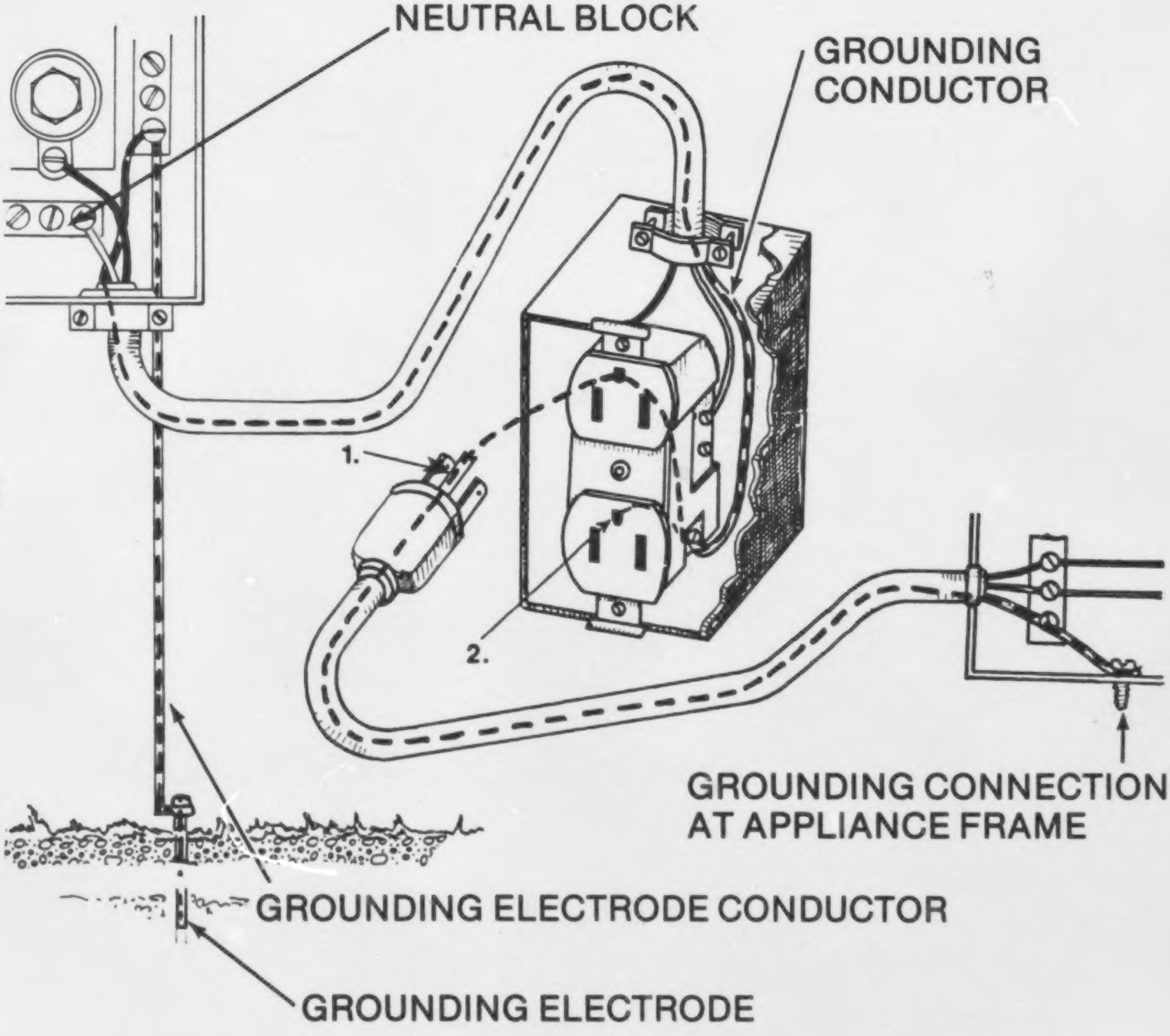
- A. Single receptacles on individual branch circuits must be rated at least equal to the branch circuit
- B. Receptacles installed on 15 and 20 ampere branch circuits shall be of the grounding type
- C. Where practical to get a source of ground, replacement receptacles for nongrounding receptacles shall be of the grounding type

  (NOTE: When a grounding conductor is not present in the box a non grounding receptacle can be used.)

PARTS OF A DUPLEX GROUNDING TYPE RECEPTACLE


MOUNTING SCREW
STRAP OR YOKE
UNGROUNDED CONTACT SLOT (NARROW)
GROUNDED CONTACT SLOT (WIDE)
UNGROUNDED TERMINAL (COPPER)
GROUNDED TERMINALS (WHITE)
BREAK-OFF FIN
GROUNDING CONTACT SLOT (SEMI-OVAL)
GROUNDING TERMINAL

EQUIPMENT GROUNDING CIRCUIT


NEUTRAL BLOCK
GROUNDING CONDUCTOR
1.
2.
GROUNDING CONNECTION AT APPLIANCE FRAME
GROUNDING ELECTRODE CONDUCTOR
GROUNDING ELECTRODE

1. ATTACHMENT CAP GROUNDING PRONG
2. RECEPTACLE GROUNDING SLOT

RECEPTACLE OUTLETS
UNIT IV

JOB SHEET #1--INSTALL A DUPLEX GROUNDING TYPE RECEPTACLE

I. Tools and equipment

- A. Lineman's pliers
- B. Long nose pliers
- C. Flat blade screwdriver
- D. Pocket knife
- E. Wire strippers
- F. Electrician's hammer
- G. 12-2 or 114-2 G NM cable
- H. Device box
- I. Electrical supply
- J. Staples
- K. 3/8" cable connector
- L. Stud wall or work board
- M. Tool pouch
- N. Folding rule with sliding scale or tape
- O. Safety glasses
- P. Drill motor or brace
- Q. 1/2" or larger wood bit

  (NOTE: Holes should be large enough to accommodate cables safely.)
- R. Extension cord
- S. Duplex grounding type receptacle
- T. Neon test light or voltmeter
- U. GFI

JOB SHEET #1

II. Procedure

A. Put on safety glasses and gather equipment

B. Mount box

(NOTE: Remember that your box set-out depends on the thickness of the wall covering to be installed.)

C. Remove a half inch knockout from the panel

(NOTE: Lineman's pliers may be needed to finish removing the raised knockout.)

D. Install cable connector

E. Bore holes for cable

(NOTE: Holes should be drilled as close to the center (front to back) of a stud as possible. Holes should be drilled at least 6 inches above or below the box depending on which route is the closest.)

(CAUTION: Be sure and hold the drill securely. A loose grip can cause an accident. Be sure and use GFI protection.)

F. Run cable

(NOTE: Leave at least 8" extending past the surface of device box, and enough to reach the top of panel plus half the width.)

G. Staple cable within 12" of metal boxes, 8" of nonmetallic boxes

H. Secure all cable clamps and connectors

(CAUTION: Tighten them until the cable will not slip in the box; overtightening can cause an electrical short.)

I. Strip cable insulation at device box and panel

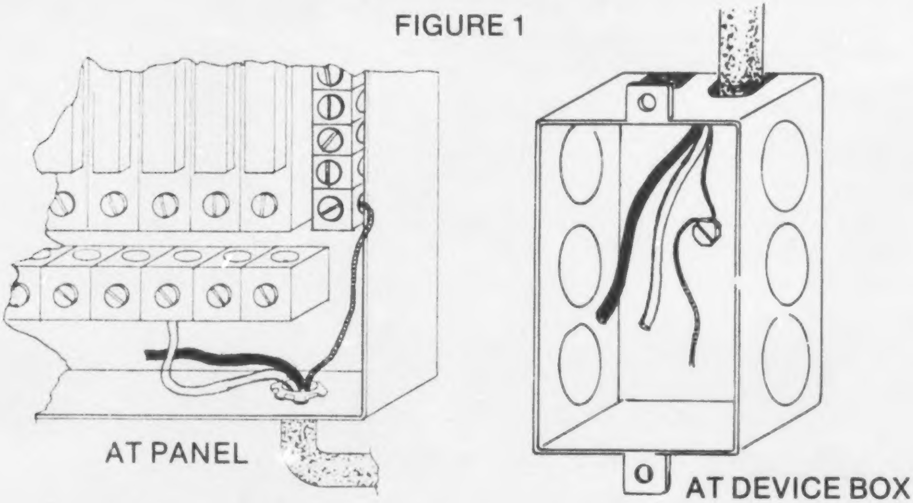
(NOTE: Trim the cable covering to within 1/4" of its point of entry.)

(CAUTION: Extreme care should always be used in operations involving the knife; a cut hand can cause pain and lost work time.)

JOB SHEET #1

J. Connect equipment grounding conductors and circuit neutral (Figure 1)

FIGURE 1


AT PANEL
AT DEVICE BOX

(NOTE: In a residence, all circuit neutrals and equipment grounding conductors would be connected at one time; the procedure is called panel make-up.)

K. Install receptacle (Figure 2)

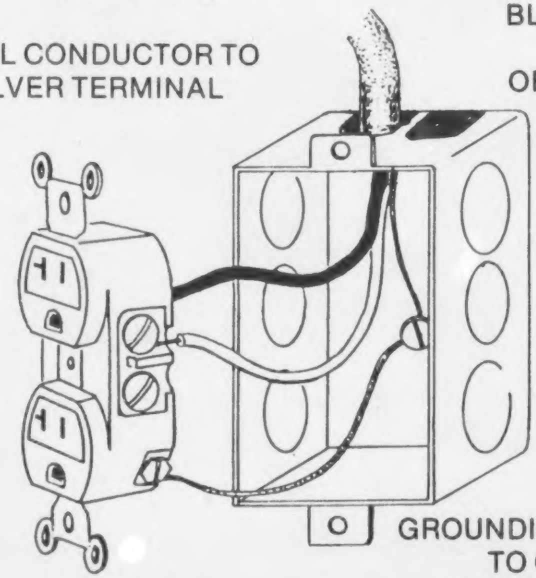

WHITE NEUTRAL CONDUCTOR TO WHITE OR SILVER TERMINAL
BLACK CONDUCTOR TO BRASS OR DARK TERMINAL
GROUNDING CONDUCTOR TO GREEN OR HEX HEADED TERMINAL

FIGURE 2

JOB SHEET #1

L. Connect ungrounded conductor to appropriate overcurrent device (Figure 3)

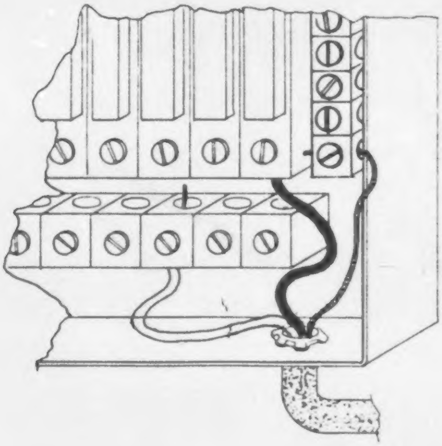


FIGURE 3

(NOTE: Be sure the breaker is off or the fuse is out before connecting this conductor. Always be safety conscious.)

M. Turn breaker on or screw fuse in

(CAUTION: Stand to the side of the panel when turning on the breaker. A short in the circuit could cause molten metal to fly from the panel.)

N. Test receptacle with neon test light or voltmeter

O. Have instructor evaluate this project

P. Turn off breaker

RECEPTACLE OUTLETS
UNIT IV

JOB SHEET #2--INSTALL A RANGE OR DRYER RECEPTACLE

I. Tools and equipment

- A. Lineman's pliers
- B. Long nose pliers
- C. Screwdriver
- D. Pocket knife
- E. Wire strippers
- F. Electrician's hammer
- G. 10-3-G or 8-3G NM cable
- H. Device box
- I. Electrical supply
- J. Staples
- K. 1/2" or 3/4" cable connector
- L. Stud wall or work board
- M. Tool pouch
- N. Folding rule with sliding scale or tape
- O. Safety glasses
- P. Drill motor or brace
- Q. 1/2" or larger wood bit
- R. Extension cord
- S. 125/250 volt, 30 or 50 amp receptacle
- T. GFI

JOB SHEET #2

II. Procedure

A. Put on safety glasses and gather equipment

B. Mount box

(NOTE: Remember that your box set out depends on the thickness of the wall covering to be installed. Be sure your box is rated for your conductors.)

C. Remove appropriate size knockout from the panel

(NOTE: Lineman's pliers may be needed to finish removing the raised knockout.)

D. Install cable connector

E. Bore holes for cable

(NOTE: Holes should be drilled as close to the center (front to back) of a stud as possible. Holes should be drilled at least 6 inches above or below the box depending on which route is the closest.)

(CAUTION: Be sure and hold the drill securely. A loose grip can cause an accident. Be sure and use GFI protection.)

F. Run cable

(NOTE: Leave at least 8" extending past the surface of your device box, and enough to reach the top of your panel plus half the width.)

G. Staple cable within 12" of all metal boxes, 8" of all nonmetallic boxes

H. Secure all cable clamps and connectors

(CAUTION: Tighten them until the cable will not slip in the box; overtightening can cause an electrical short.)

I. Strip cable insulation at device box and panel

(NOTE: Trim the cable covering to within 1/4" of its point of entry.)

(CAUTION: Extreme care should always be used in operations involving the knife; a cut hand can cause pain and lost work time.)

JOB SHEET #2

J. Connect neutral and equipment grounding conductors (Figure 1)

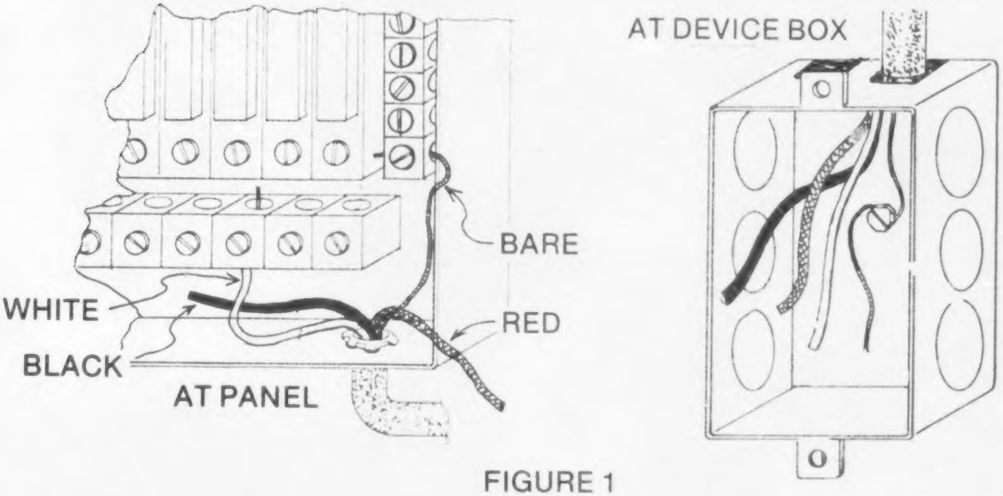

AT DEVICE BOX
BARE
WHITE
RED
BLACK
AT PANEL

FIGURE 1

(NOTE: You are allowed to use the grounded circuit conductor as the equipment grounding conductor for the frames of ranges and dryers if specific conditions in Article 250 are met.)

K. Install your device (Figure 2)

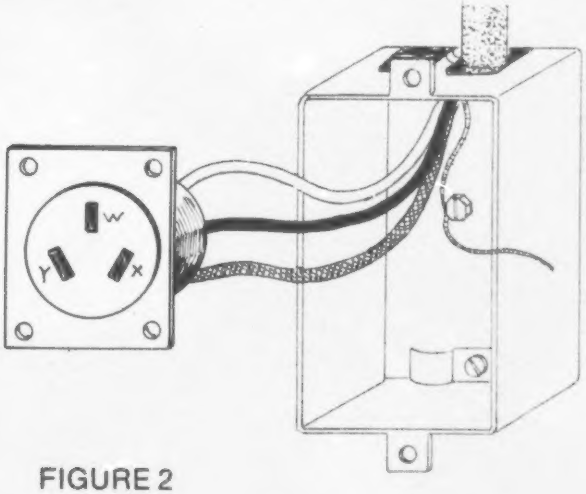


FIGURE 2

(NOTE: White conductor goes to terminal labeled "W" or Gr. The red and black connect to other terminals.)

JOB SHEET #2

L. Connect ungrounded conductors to appropriate overcurrent device (Figure 3)

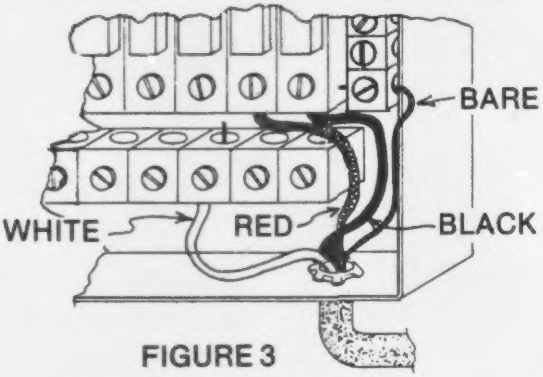


FIGURE 3

(NOTE: Be sure the breaker is off or the fuse is out before connecting these conductors. Always be safety conscious.)

M. Turn breaker on or screw fuse in

(CAUTION: Stand to the side of the panel when turning on the breaker. A short in the circuit could cause molten metal to fly from the panel.)

N. Test receptacle with neon test light or voltmeter

O. Have instructor evaluate this project

P. Turn off breaker

RECEPTACLE OUTLETS
UNIT IV

JOB SHEET #3--INSTALL A MULTI-CIRCUIT SPLIT-WIRED DUPLEX GROUNDING TYPE RECEPTACLE

I. Tools and equipment

- A. Lineman's pliers
- B. Long nose pliers
- C. Flat blade screwdriver
- D. Pocket knife
- E. Wire strippers
- F. Electrician's hammer
- G. 12-3 or 14-2G NM cable
- H. Device box
- I. Electrical supply
- J. Staples
- K. 3/8" cable connector
- L. Stud wall or work board
- M. Tool pouch
- N. Folding rule with sliding scale or tape
- O. Safety glasses
- P. Drill motor or brace
- Q. 1/2" or larger wood bit
- R. Extension cord

II. Procedure

- A. Put on safety glasses and gather equipment
- B. Mount box

  (NOTE: Remember that the box set-out depends upon the thickness of the wall covering to be installed.)

JOB SHEET #3

C. Remove a half inch knockout from the panel

(NOTE: Lineman's pliers may be needed to finish removing the raised knockout.)

D. Install cable connector

E. Bore holes for cable

(NOTE: Holes should be drilled as close to the center (front to back) of a stud as possible. Holes should be drilled at least 6 inches above or below the box depending on which route is the closest.)

(CAUTION: Be sure and hold the drill securely. A loose grip can cause an accident.)

F. Run cable

(NOTE: Leave at least 8" extending past the surface of your device box, and enough to reach the top of your panel plus half the width.)

G. Staple cable within 12" of the box

H. Secure all cable clamps and connectors

(CAUTION: Tighten them until the cable will not slip in the box; overtightening can cause an electrical short.)

I. Strip cable insulation at device box and panel

(CAUTION: Extreme care should always be used in operations involving the knife; a cut hand can cause pain and lost work time.)

J. Connect equipment grounding conductors and panel neutral

(NOTE: In a residence, all circuit neutrals and equipment grounding conductors would be connected at one time; the procedure is called panel make-up.)

K. Break connecting fin from ungrounded side of receptacle (Figure 1)

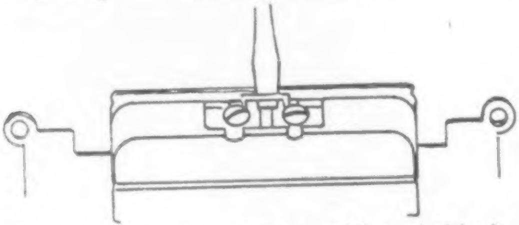


FIGURE 1

(NOTE: Repeated bending motions will probably be needed to remove the connecting fin.)

JOB SHEET #3

L. Install receptacle (Figure 2)

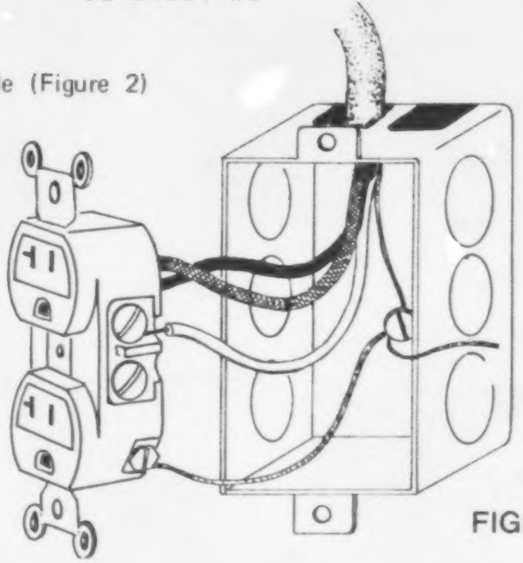


FIGURE 2

(NOTE: A common neutral is allowed on multi-wire branch circuits where there is a dual voltage potential difference between ungrounded conductors.)

M. Connect ungrounded conductor to appropriate overcurrent devices (Figure 3)

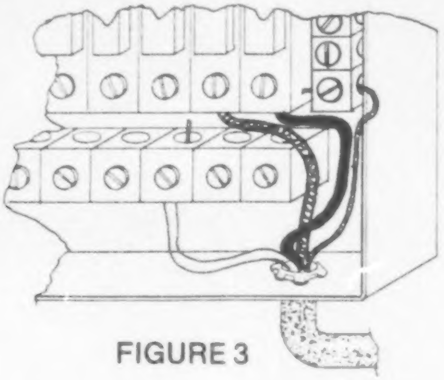


FIGURE 3

(NOTE: Be sure the breakers are off or the fuses are out before connecting these conductors. Always be safety conscious.)

N. Turn breaker on or screw fuse in

(CAUTION: Stand to the side of the panel when turning on the breaker. A short in the circuit could cause molten metal to fly from the panel.)

O. Test receptacles with neon test light or voltmeter

P. Have instructor evaluate this project

Q. Turn off breaker

RECEPTACLE OUTLETS
UNIT IV

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

______a. Current carrying conductors, both grounded and ungrounded, on a receptacle

______b. Metal strip containing one or more devices

______c. A single device with two or more receptacles

______d. Current carrying conductors and grounding conductors

______e. A single contact device with no other contact device on the same yoke

______f. A single device with two grounding type receptacles

1. Poles
2. Wires
3. Strap or yoke
4. Single receptacle
5. Multiple receptacle
6. Duplex grounding receptacle

2. Identify the parts of the duplex grounding type receptacle.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

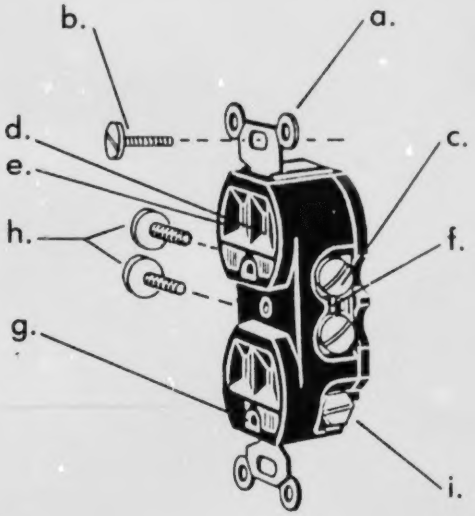
e. ____________________

f. ____________________

g. ____________________

h. ____________________

i. ____________________



3. Identify the parts of the equipment grounding circuit.

a. ______________________

b. ______________________

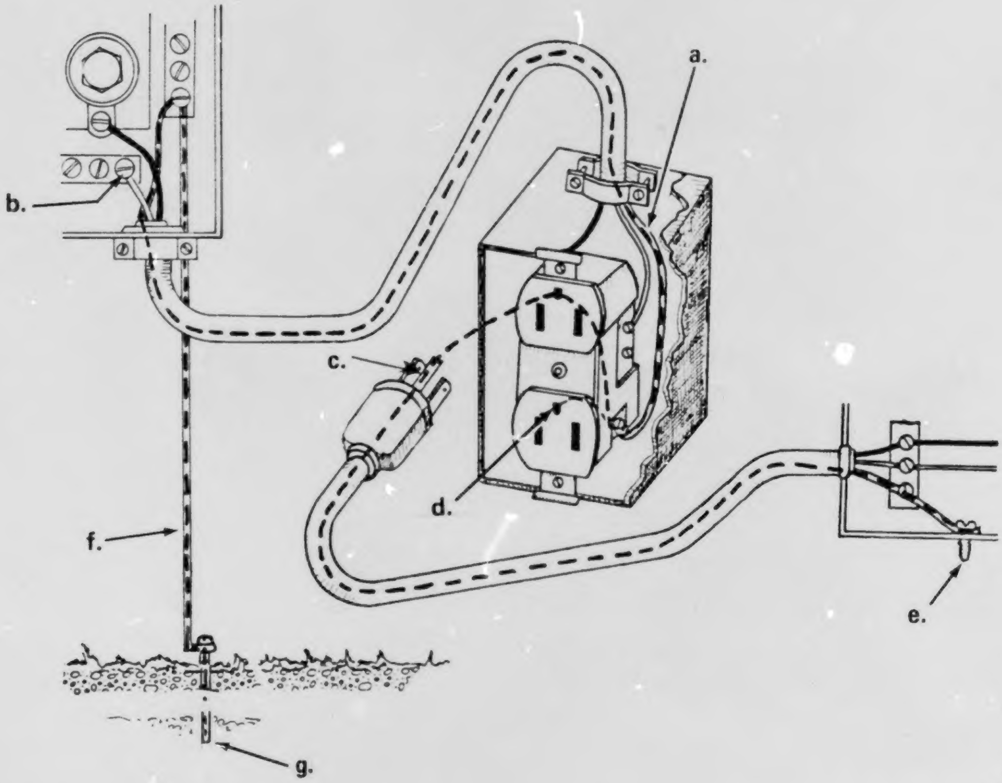
c. ______________________

d. ______________________

e. ______________________

f. ______________________

g. ______________________



4. List three NEC requirements pertaining to receptacles.

   a.

   b.

   c.

5. Demonstrate the ability to:

   a. Install a duplex grounding type receptacle.

   b. Install a range or dryer receptacle.

   c. Install a multi-circuit split-wired duplex grounding type receptacle.

   (NOTE: If these activities have not been completed prior to the test, ask your instructor when they should be completed.)

RECEPTACLE OUTLETS
UNIT IV

ANSWERS TO TEST

1. a. 1 d. 2
   b. 3 e. 4
   c. 5 f. 6
2. a. Strap or yoke
   b. Mounting screws
   c. Ungrounded terminal
   d. Ungrounded contact slot
   e. Grounded contact slot
   f. Break off fin
   g. Grounding contact slot
   h. Grounded terminals
   i. Grounding terminal
3. a. Grounding conductor
   b. Neutral block or bus bar
   c. Attachment cap grounding prong
   d. Receptacle grounding slot
   e. Grounding connection at appliance frame
   f. Grounding electrode conductor
   g. Grounding electrode
4. a. Single receptacles on individual branch circuits must be rated at least equal to the branch circuit
   b. Receptacles installed on 15 and 20 ampere branch circuits shall be of the grounding type
   c. Where practical to get a source of ground, replacement receptacles for nongrounding receptacles shall be of the grounding type
5. Performance skills evaluated to the satisfaction of the instructor

COMBINATION CIRCUITS
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms and list general rules for electrical installations, as well as list agencies that can set standards for these installations. The student should also be able to wire various combination circuits. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with combination circuits to the correct definitions.
2. List rules for electrical installations.
3. List three agencies or governing bodies that can set standards for electrical installations.
4. Demonstrate the ability to:
    a. Wire a switch controlled split wired receptacle.
    b. Wire a receptacle fed from a lighting outlet through a single pole switch.
    c. Wire a receptacle fed from a lighting outlet through a three-way switch.

COMBINATION CIRCUITS
UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Discuss unit and specific objectives.

   D. Discuss information sheet.

   E. Demonstrate and discuss the procedures outlined in the job sheets.

   F. Make extra project assignments to build proficiency.

   G. Reinforce safety precautions.

   H. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Job sheets

      1. Job Sheet #1--Wire a Switch Controlled Split Wired Receptacle

      2. Job Sheet #2--Wire a Receptacle Fed from a Lighting Outlet Through a Single Pole Switch

      3. Job Sheet #3--Wire a Receptacle Fed from a Lighting Outlet Through a Three-Way Switch

   D. Test

   E. Answers to test

II. Reference--*National Electrical Code* 1981. Boston: National Fire Protection Association, 1980.

COMBINATION CIRCUITS
UNIT V

INFORMATION SHEET

Terms and definitions

A. Receptacle connecting fin--Detachable design feature that makes terminals common connections

B. Split wired receptacle--Receptacle that has had a connecting fin removed for remote control or separate circuit connections

C. Pigtail--Splicing technique that leaves an accessible conductor for termination at a device, load, or grounding terminal

D. Feed through--The use of a box for splicing or rerouting conductors to get to another location

II. Rules for electrical installations

A. Always be safety conscious

B. Do work you will be proud of

C. Be sure all connections are secure and well insulated

D. Always be sure that overcurrent protection is matched to your conductor rating

E. Preform conductors before installing devices in boxes

F. Use appropriate tools

G. Always meet or exceed NEC and local code minimum installation requirements

III. Agencies or governing bodies that can set standards for electrical installations

A. National Fire Protection Association through NEC

B. State governments through state codes

C. Local municipalities through city codes

COMBINATION CIRCUITS
UNIT V

JOB SHEET #1--WIRE A SWITCH CONTROLLED SPLIT WIRED RECEPTACLE

I. Tools and equipment

A. 12-2G or 14-2-G NM cable

B. 12-3-G or 14-3-G NM cable

C. Two device boxes

(NOTE: Be sure boxes have a NEC capacity rating to accommodate the conductors you will install.)

D. Staples

E. Single pole switch

F. Duplex grounding type receptacle

G. Stud wall or work board

H. 120v supply

(NOTE: The overcurrent protection on this supply should not exceed the conductors NEC ampacity rating.)

I. 3/8" cable clamp

J. Wire connectors

K. Four 16 penny nails or other fasteners as needed to secure the boxes

L. Electrician's hammer

M. Plain tip screwdriver

N. Lineman's pliers

O. Needle-nose pliers

P. Pocket knife

Q. Wire strippers

JOB SHEET #1

R. Tool pouch

S. Drill motor or brace

T. 1/2" or larger wood bit

U. Extension cord

V. Safety glasses

W. GFI

II. Procedure

A. Put on safety glasses and gather tools and equipment

B. Mount boxes (Figure 1)

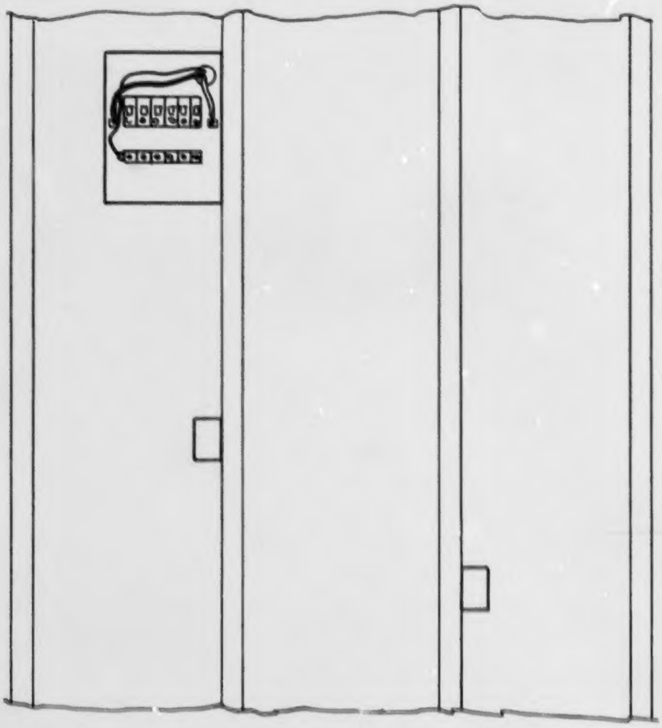


FIGURE 1

JOB SHEET #1

C. Remove a half inch knockout from the panel

D. Install cable connector

E. Bore holes for cable

(NOTE: Holes should be drilled as close to the center (front to back) of a stud as possible. Holes should be drilled at least 6 inches above or below the box depending on which route is the closest.)

(CAUTION: Be sure and use a GFI when drilling.)

F. Run cable between boxes and to panel (Figure 2)

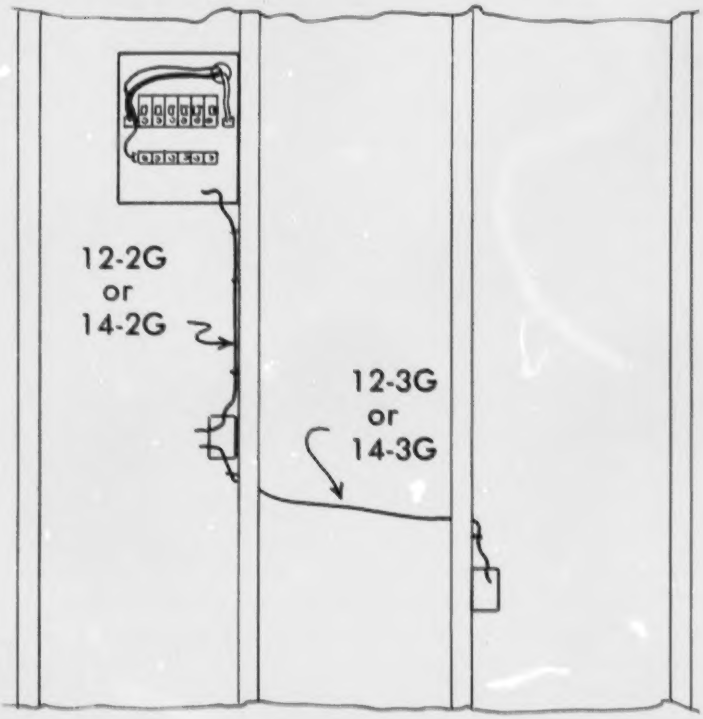


FIGURE 2

(NOTE: Leave at least 8" extending past the surface of your device boxes, and enough to reach the top of your panel plus half the width.)

JOB SHEET #1

G. Staple cable within 12" of metal boxes, 8" of all nonmetallic boxes

H. Secure all cable clamps and connectors

(CAUTION: Tighten them until the cable will not slip in the box; overtightening can cause an electrical short.)

I. Strip cable insulation at device box and panel

JOB SHEET #1

J. Connect equipment grounding conductors (Figure 3)

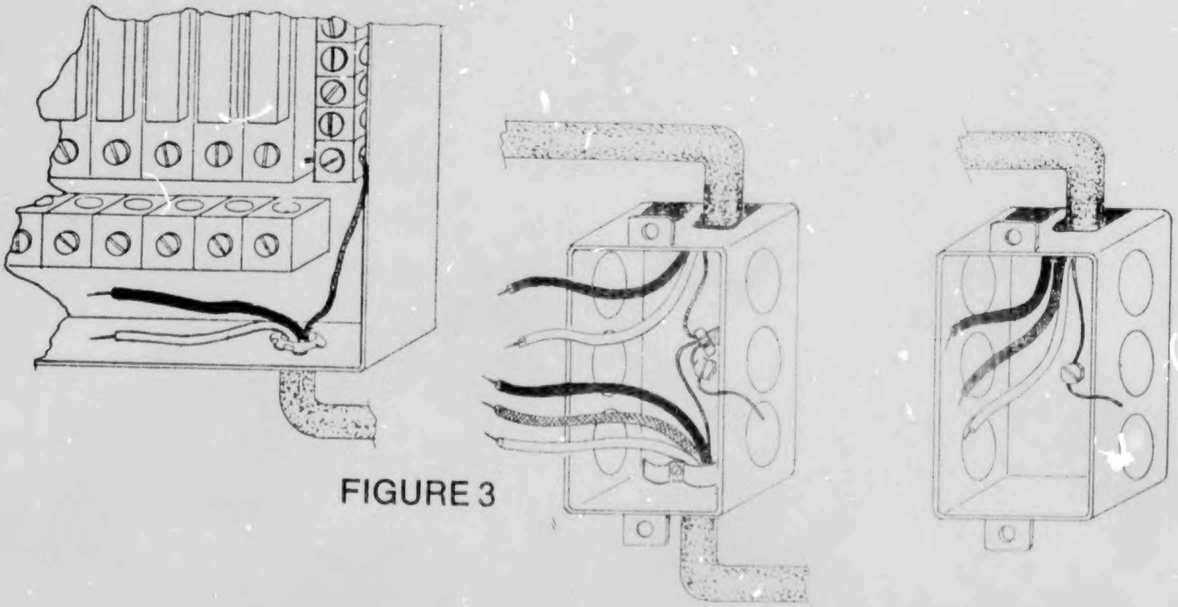


FIGURE 3

K. Make up switch box (Figure 4)

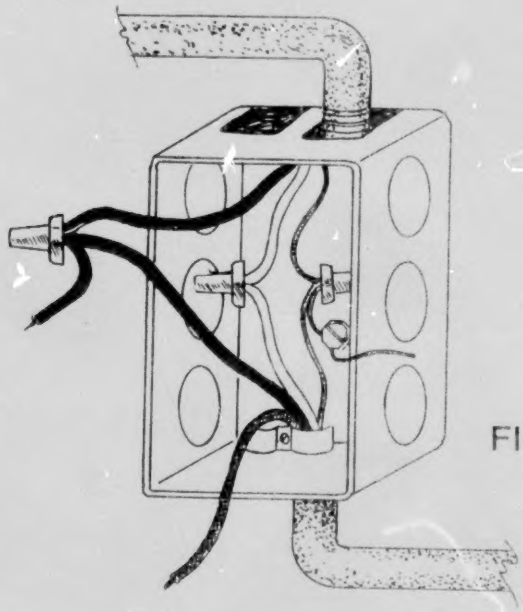


FIGURE 4

JOB SHEET #1

L. Install switch (Figure 5)

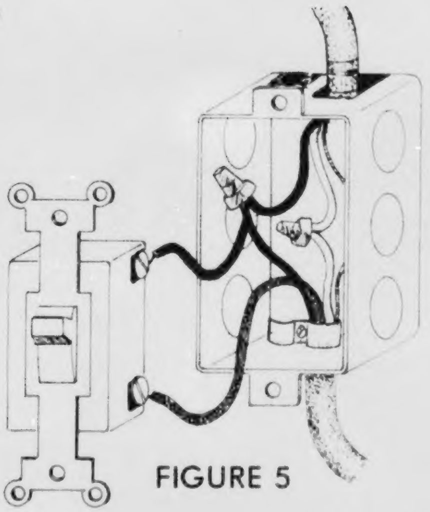


FIGURE 5

M. Break connecting fin from ungrounded side of receptacle (Figure 6)

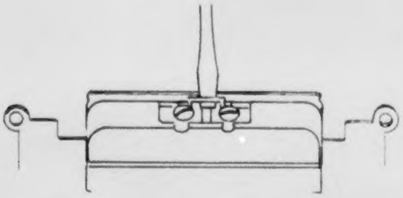


FIGURE 6

(NOTE: Repeated bending motions will probably be needed to remove the connecting fin.)

N. Install receptacle (Figure 7)

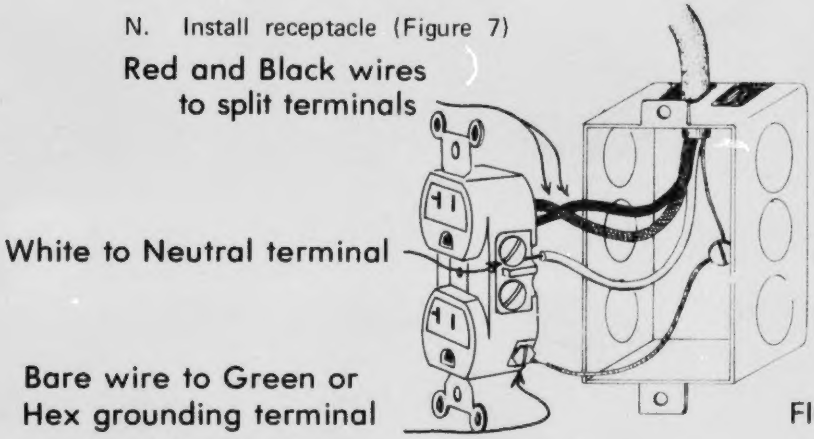

Red and Black wires to split terminals
White to Neutral terminal
Bare wire to Green or Hex grounding terminal

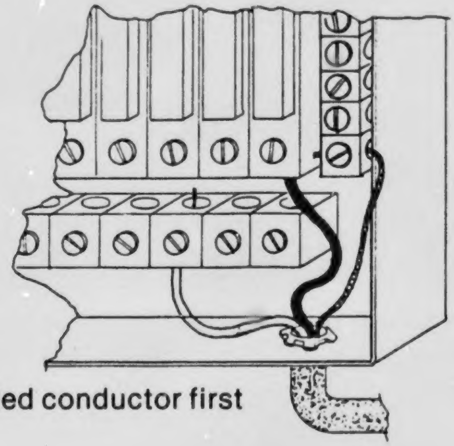
FIGURE 7

(NOTE: If the circuit continues, neutrals must be pigtailed before they are installed to the device terminal.)

JOB SHEET #1

O. Connect grounded and ungrounded conductors (Figure 8)

FIGURE 8



Connect grounded conductor first

(NOTE: Be sure the breaker is off or the fuse is out before connecting this conductor. Always be safety conscious.)

P. Turn breaker on or screw fuse in

(CAUTION: Stand to the side of the panel when turning on the breaker. A short in the circuit could cause molten metal to fly from the panel.)

Q. Test receptacle with neon test light or voltmeter

R. Have your instructor evaluate this project

S. Turn off breaker

COMBINATION CIRCUITS
UNIT V

JOB SHEET #2--WIRE A RECEPTACLE FED FROM A LIGHTING OUTLET THROUGH A SINGLE POLE SWITCH

I. Tools and equipment

A. 12-2-G or 14-2-G NM cable

B. 12-3-G or 14-3-G NM cable

C. Two device boxes

D. Octagon box and bar hanger

E. Light socket

F. 120 volt bulb

G. Staples

H. Single pole switch

I. Duplex grounding type receptacle

J. Stud wall or work board

K. 120v supply

(NOTE: The overcurrent protection on this supply should not exceed the conductors NEC ampacity rating.)

L. Wire connectors

M. Four 16 penny nails or other fasteners as needed to secure the boxes

N. Electrician's hammer

O. Plain tip screwdriver

P. Lineman's pliers

Q. Long nose pliers

R. Pocket knife

S. Wire strippers

T. Tool pouch

U. Drill motor or brace

V. 1/2" or larger wood bit

JOB SHEET #2

W. Extension cord

X. Safety glasses

Y. GFI

II. Procedure

A. Put on safety glasses and gather tools and equipment

B. Mount boxes (Figure 1)

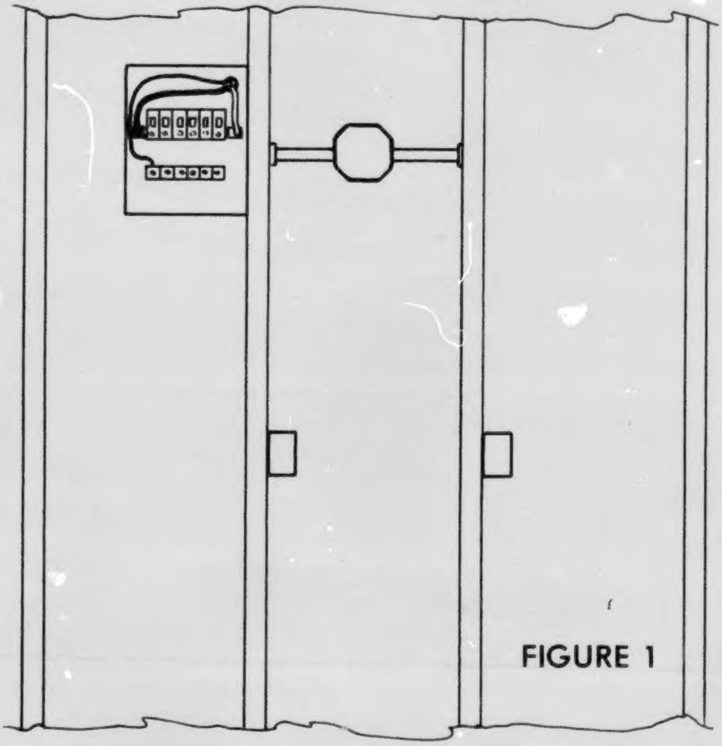


FIGURE 1

C. Remove a half inch knockout from the panel

D. Install cable connector

E. Bore holes for cable

(NOTE: Holes should be drilled as close to the center (front to back) of a stud as possible. Holes should be drilled at least 6 inches above or below the box depending on which route is the closest.)

(CAUTION: Always use a GFI when drilling.)

JOB SHEET #2

F. Run cable between boxes and to panel (Figure 2)

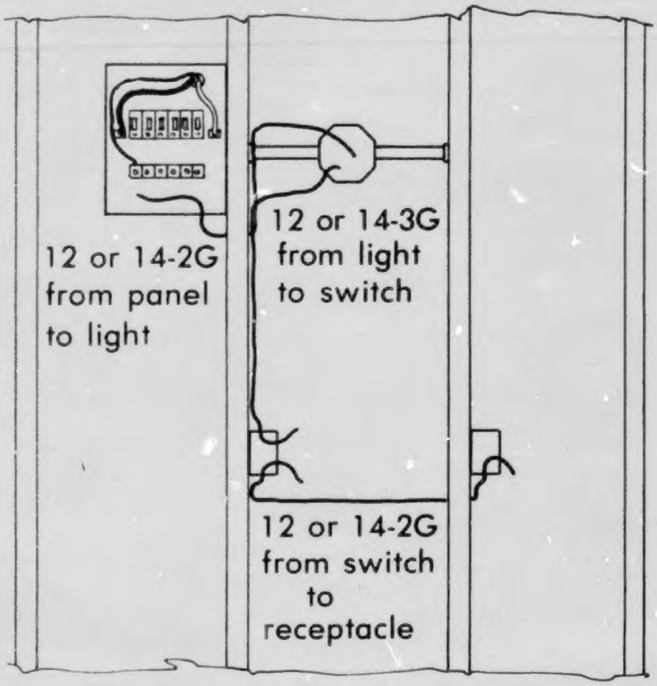

12 or 14-2G from panel to light
12 or 14-3G from light to switch
12 or 14-2G from switch to receptacle

FIGURE 2

(NOTE: Leave at least 8" extending past the surface of your device boxes, and enough to reach the top of your panel plus half the width.)

G. Staple cable within 12" of metal boxes, 8" of nonmetallic boxes

H. Secure all cable clamps and connectors

(CAUTION: Tighten them until the cable will not slip in the box; overtightening can cause an electrical short.)

I. Strip cable insulation at device box and panel

JOB SHEET #2

J. Connect equipment grounding conductors (Figure 3)

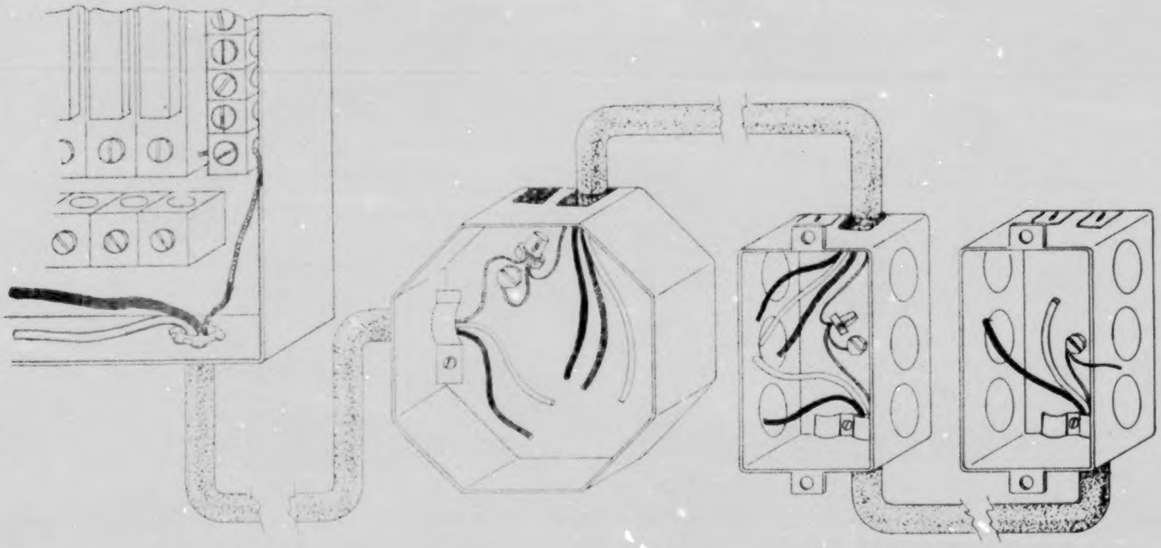


FIGURE 3

K. Make up neutral through the system (Figure 4)

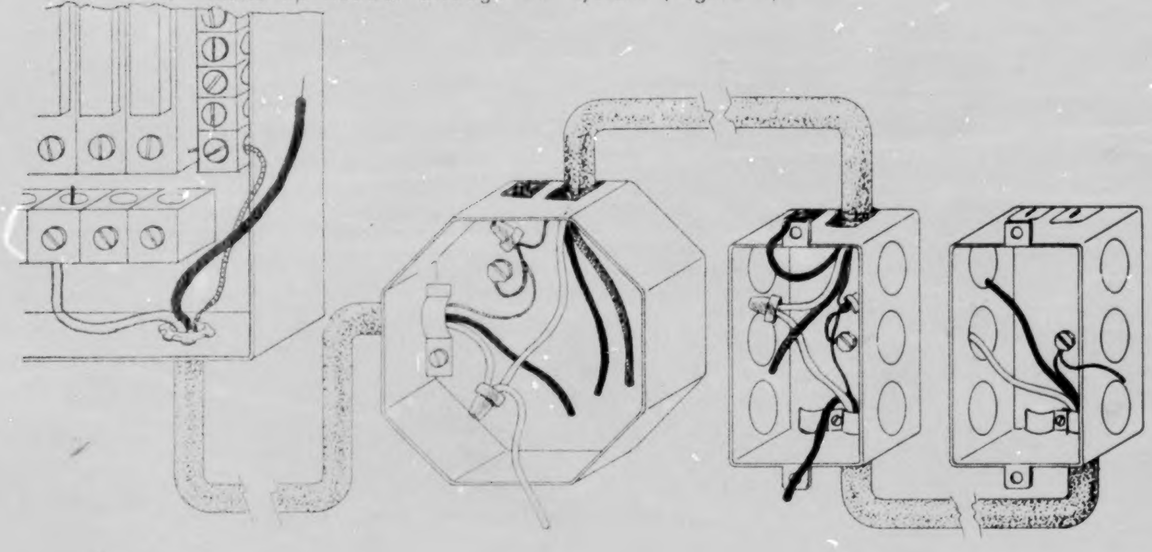


FIGURE 4

JOB SHEET #2

L. Make up switch, return, and feed through conductors (Figure 5)

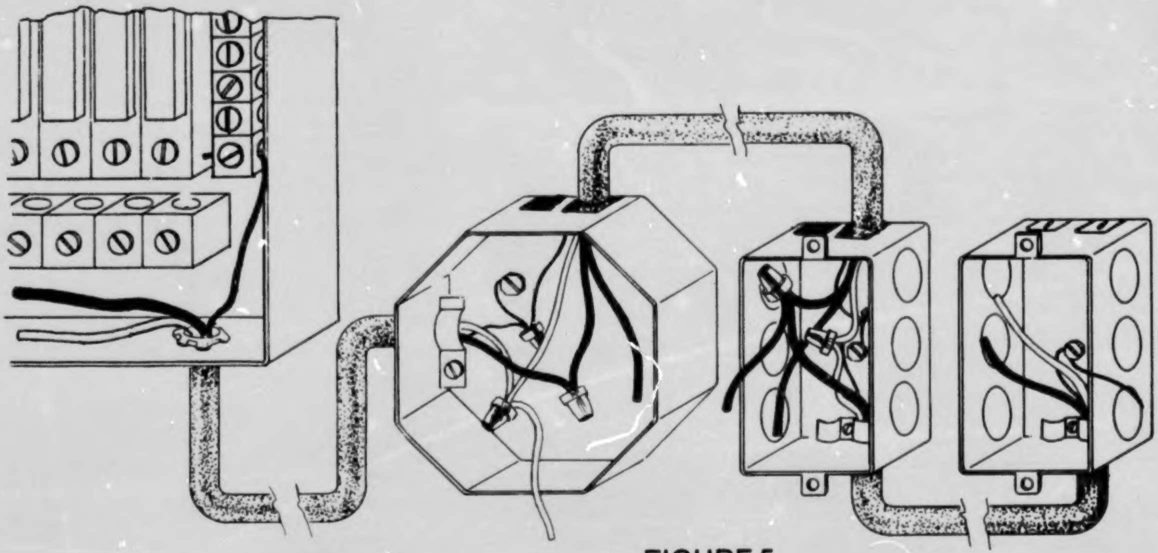
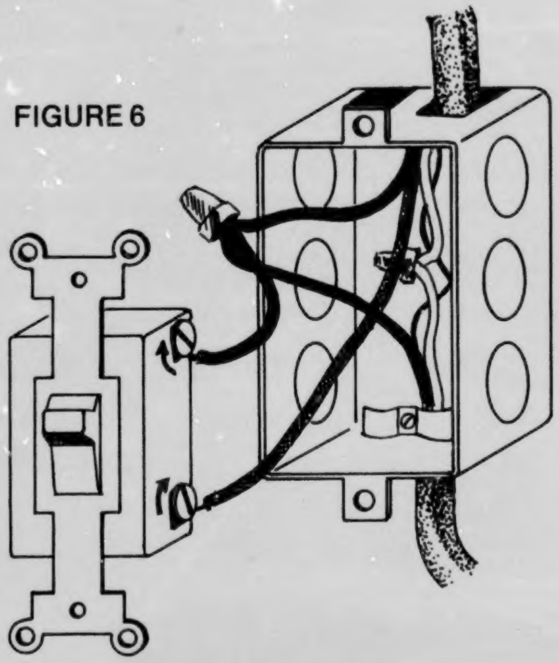


FIGURE 5

M. Install switch (Figure 6)

FIGURE 6



JOB SHEET #2

N. Install receptacle (Figure 7)

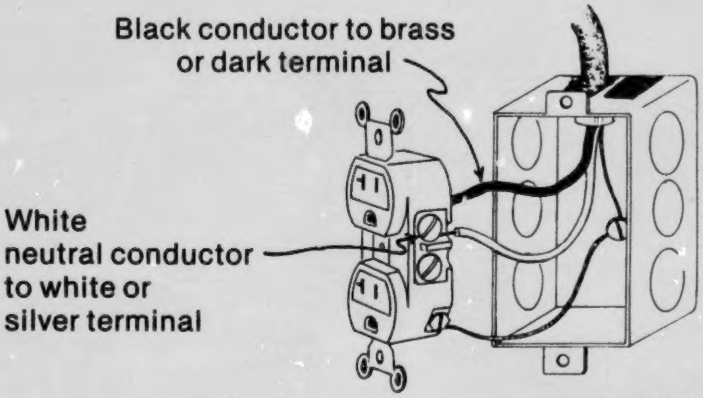
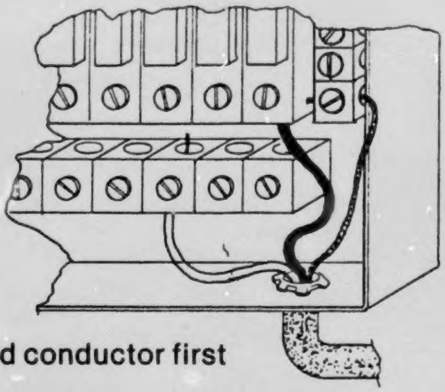

Black conductor to brass or dark terminal
White neutral conductor to white or silver terminal

FIGURE 7

O. Connect return leg and neutral to light socket

P. Connect ungrounded conductor (Figure 8)

FIGURE 8


Connect grounded conductor first

(NOTE: Be sure the breaker is off or the fuse is screwed out before connecting these conductors. Always be safety conscious.)

R. Turn on breaker or screw in fuse

S. Turn on switch

(NOTE: Light should burn.)

T. Test receptacle with test light or V.O.M.

U. Have your instructor inspect this project

V. Turn off breaker

COMBINATION CIRCUITS
UNIT V

JOB SHEET #3--WIRE A RECEPTACLE FED FROM A LIGHTING OUTLET THROUGH A THREE-WAY SWITCH

I. Tools and equipment

- A. 12-2-G or 14-2-G NM cable
- B. 12-3-G or 14-3-G NM cable
- C. Three device boxes

  (NOTE: One of the device holding boxes will have to be a 4" square box with a plaster ring.)

- D. Octagon box and bar hanger

  (NOTE: Be sure boxes have a NEC capacity rating to accommodate the conductors to be installed.)

- E. Staples
- F. Two 3-way switches
- G. One duplex grounding type receptacle
- H. Light socket
- I. Bar hanger

  (NOTE: If a bracket octagon box is used or if this job is installed on a work board, a bar hanger will not be needed.)

- J. Stud wall or work board
- K. 120v supply

  (NOTE: The overcurrent supply should not exceed your conductors NEC capacity rating.)

- L. 3/8" cable clamp
- M. 120v incandescent bulb
- N. Wire connectors

  (NOTE: Twist on connectors will be used in this manual for illustrations. Wire connectors, pressure connectors or solder would also be acceptable in the trade.)

- O. Two 16 penny nails

JOB SHEET #3

P. Two plasterboard nails

Q. Electrician's hammer

R. Plain tip screwdriver

S. Lineman's pliers

T. Long nose pliers

U. Pocket knife

V. Wire strippers

W. Tool pouch

X. Drill motor or brace

Y. 1/2" or larger wood bit

Z. Extension cord

AA. Safety glasses

BB. GFI

II. Procedure

A. Put on safety glasses and gather tools and equipment

B. Mount boxes (Figure 1)

(NOTE: Device boxes and ceiling can be mounted at any height in this project.)

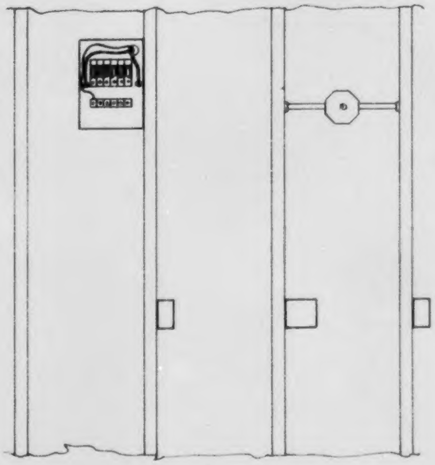


FIGURE 1

JOB SHEET #3

C. Remove a half inch knockout from the panel

D. Install cable connector

E. Bore holes for cable

(NOTE: Holes should be drilled as close to the center (front to back) of a stud as possible. Holes should be drilled at least 6 inches above or below box depending on which route is the closest.)

(CAUTION: Be sure and hold the drill securely. A loose grip can cause an accident. Be sure and use a GFI while drilling.)

F. Run cable (Figure 2)

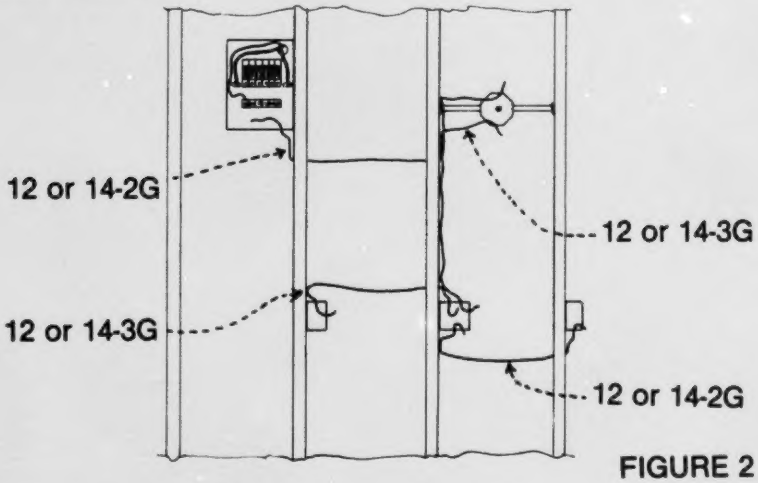


FIGURE 2

(NOTE: Leave at least 8" extending past the surface of your device and lighting outlet boxes, and enough to reach the top of your panel plus half the width.)

G. Staple cable within 12" of metal boxes, 8" of nonmetallic boxes

H. Secure all cable clamps and connectors

(CAUTION: Tighten them until the cable will not slip in the box; overtightening can cause an electrical short.)

I. Strip cable insulation

(CAUTION: Extreme care should always be used in operations involving the knife; a cut hand can cause pain and lost work time.)

JOB SHEET #3

J. Connect all grounding conductors (Figure 3)

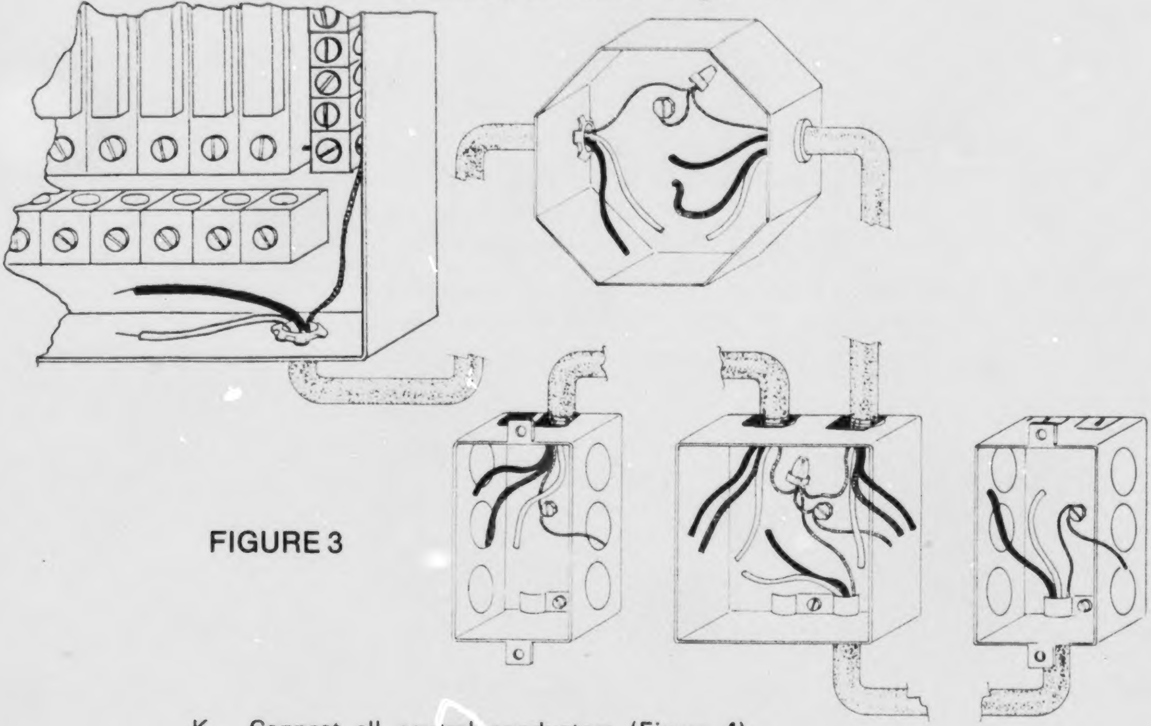


FIGURE 3

K. Connect all neutral conductors (Figure 4)

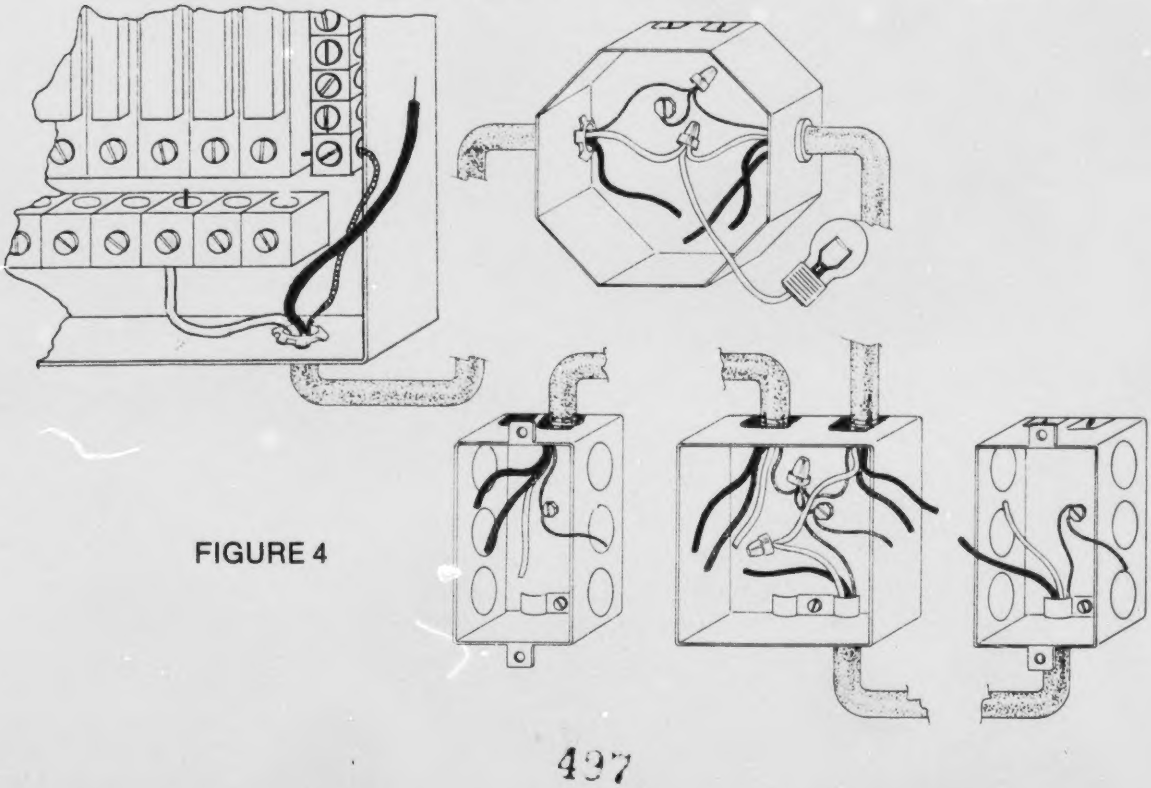


FIGURE 4

JOB SHEET #3

L. Connect switch leg through the system (Figure 5)

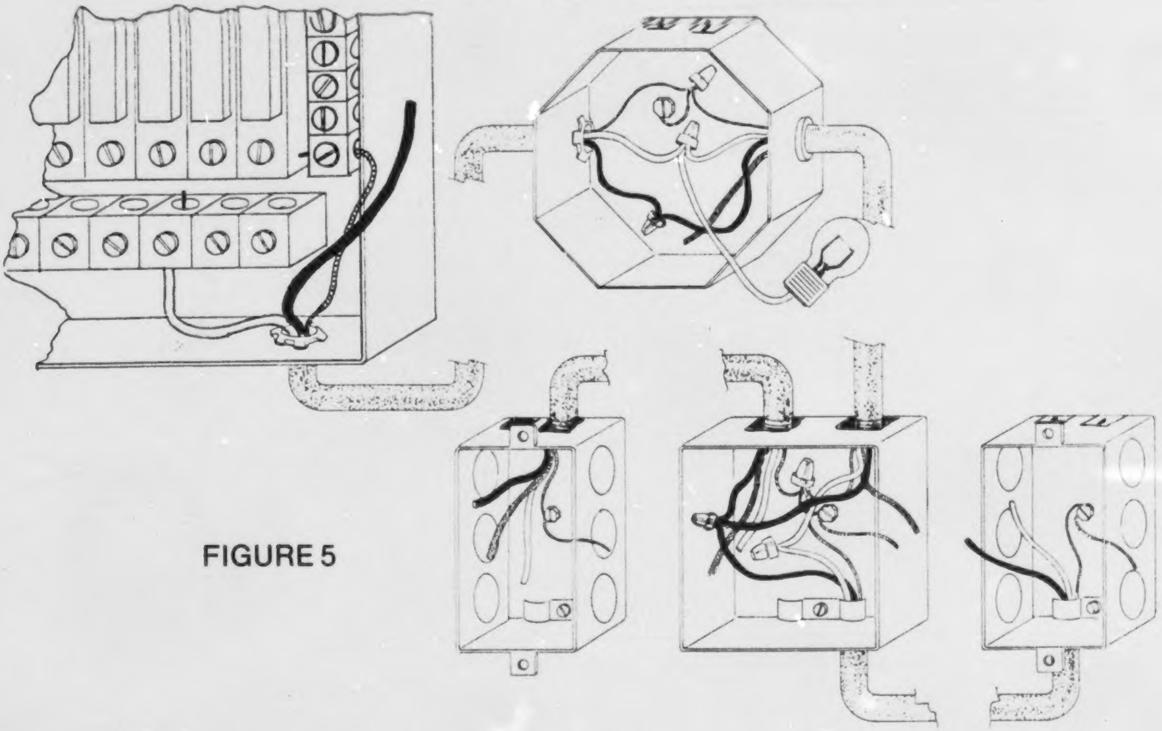


FIGURE 5

M. Install switches (Figure 6)

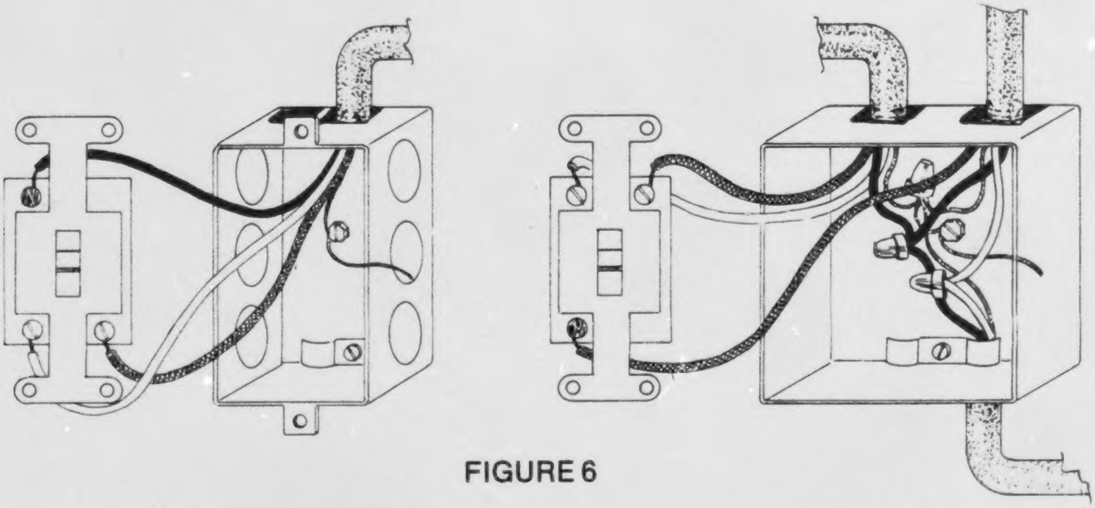


FIGURE 6

N. Connect return leg to socket

JOB SHEET #3

O. Install receptacle (Figure 7)

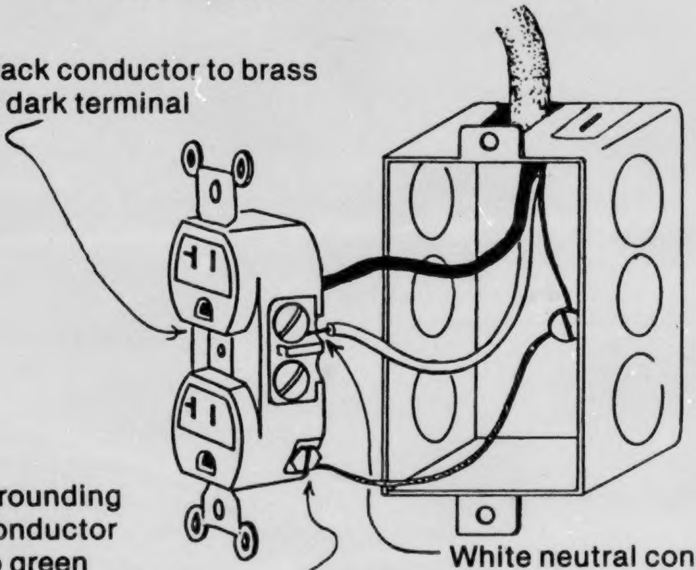

Black conductor to brass
or dark terminal
Grounding
conductor
to green
or hex headed terminal
White neutral conductor to
white or silver terminal

FIGURE 7

P. Connect ungrounded conductor to appropriate overcurrent device (Figure 8)

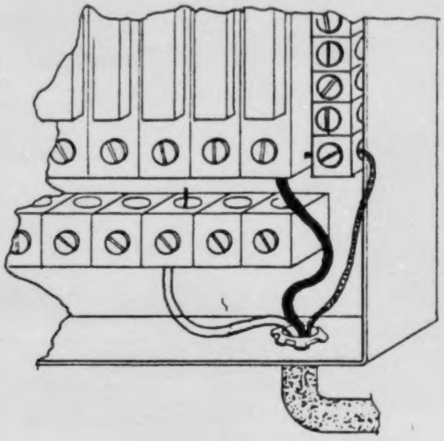


FIGURE 8

(CAUTION: Be sure the breaker is off or the fuse is out before connecting this conductor. Always be safety conscious.)

Q. Turn breaker on

(CAUTION: Stand to the side of the panel when turning on the breaker. A short in the circuit could cause molten metal to fly from the panel.)

JOB SHEET #3

R. Change the position of the switches in alternating movements

(NOTE: Be sure you can turn the light on or off from switch as well as on at one end and off at the other.)

S. Check receptacle with neon test light or voltmeter

T. Have your instructor evaluate this project

U. Turn off breaker

COMBINATION CIRCUITS
UNIT V

NAME ______________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Detachable design feature that makes terminals common connections

_____b. Receptacle that has had a connecting fin removed for remote control or separate circuit connections

_____c. Splicing technique that leaves an accessible conductor for termination at a device, load, or grounding terminal

_____d. The use of a box for splicing or rerouting conductors to get to another location

1. Pigtail
2. Split wired receptacle
3. Receptacle connecting fin
4. Feed through

2. List five rules for electrical installations.

a.

b.

c.

d.

e.

3. List three agencies or governing bodies that can get standards for electrical installations.

a.

b.

c.

4. Demonstrate the ability to:
    a. Wire a switch controlled split wired receptacle.
    b. Wire a receptacle fed from a lighting outlet through a single pole switch.
    c. Wire a receptacle fed from a lighting outlet through a three-way switch.

    (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

COMBINATION CIRCUITS
UNIT V

ANSWERS TO TEST

1. a. 3

   b. 2

   c. 1

   d. 4

2. Any five of the following:

   a. Always be safety conscious

   b. Do work you will be proud of

   c. Be sure all connections are secure and insulated

   d. Always be sure that overcurrent protection is matched to your conductor rating

   e. Preform conductors before installing devices in boxes

   f. Use appropriate tools

   g. Always meet or exceed NEC and local code minimum installation requirements

3. a. National Fire Protection Association through NEC

   b. State governments through state codes

   c. Local municipalities through city codes

4. Performance skills evaluated to the satisfaction of the instructor

LOW VOLTAGE WIRING
UNIT VI

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms to their definitions, describe processes or circuits created in low voltage wiring and discuss heat anticipation circuits on thermostats. The student should also be able to wire various low voltage circuits. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with low voltage wiring to the correct definitions.
2. Identify the parts of a low voltage lighting system.
3. Describe the process that takes place during a low voltage lighting circuit off/on cycle.
4. Describe the process that takes place during the energizing of a chime circuit.
5. Describe the manual fan switching circuit.
6. Describe the circuit that is created when the thermostat system switch is in the cool position and the fan switch is in automatic.
7. Describe the circuit that is created when the system switch is in the heat position.
8. Discuss anticipation circuits on low voltage thermostats.
9. Demonstrate the ability to:
   a. Wire a two switch low voltage lighting circuit.
   b. Wire a two button chime circuit.
   c. Determine heat anticipator current draw.
   d. Install a wall thermostat.

LOW VOLTAGE WIRING
UNIT VI

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide student with objective sheet.
- B. Provide student with information and job sheets.
- C. Make transparencies.
- D. Discuss unit and specific objectives.
- E. Discuss information sheet.
- F. Demonstrate and discuss the procedures outlined in the job sheets.
- G. Discuss advantages and disadvantages of low voltage lighting.
- H. Discuss NEC Article 725.
- I. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Complete job sheets.
- D. Participate in a group discussion about the advantages and disadvantages of low voltage wiring.
- E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Transparency masters
    1. TM 1--Parts of a Low Voltage Lighting System
    2. TM 2--Low Voltage Off/On Switching Cycle

    3. TM 3--Thermostat--Manual Fan Control
    4. TM 4--Thermostat--Cooling Circuit with Automatic Fan Control
    5. TM 5--Thermostat--Heating Circuit with Automatic Fan Control

  D. Job sheets

    1. Job Sheet #1--Wire a Two Switch Low Voltage Lighting Circuit
    2. Job Sheet #2--Wire a Two Button Chime Circuit
    3. Job Sheet #3--Determine Heat Anticipator Current Draw
    4. Job Sheet #4--Install a Wall Thermostat

  E. Test

  F. Answers to test

II. References:

A. Mix, Floyd, and Pritchard, E. C. *All About House Wiring.* Homewood, Illinois: The Goodheart-Willcox Co., Inc., 1962.

B. *Touch-Plate Low Voltage Light Control.* Paramount, California: Touch-Plate Electro Systems, Inc.

LOW VOLTAGE WIRING
UNIT VI

INFORMATION SHEET

I. Terms and definitions

   A. Transformer--An electrical device used to step up or step down a primary voltage to a desired secondary voltage

   B. Momentary contact switch--A switch that is closed or open only while the operator touches it

   C. Solenoid--Electromagnetic cylinder that will pull a movable plunger into it when current is applied

   D. Relay--Electromagnetic device for remote or automatic control

   E. Thermostat--A device that senses temperature variations from a set point and, in turn, acts to control a circuit

   F. Pull-push solenoid--Solenoid with two electromagnetic circuits that will pull or push a plunger depending on which magnet has current applied to it

II. Parts of a low voltage lighting system (Transparency 1)

   A. 24 volt transformer

   B. Low voltage lighting relay

   C. Momentary contact switch

   D. Low voltage cable

III. Low voltage lighting circuit off/on cycle (Transparency 2)

   A. "On" switch is pushed

      1. Circuit is completed to closing movement of solenoid in relay

      2. Core is moved and circuit is completed

   B. "Off" switch is pushed

      1. Circuit is completed to opening movement of solenoid in relay

      2. Core is moved and circuit is opened

INFORMATION SHEET

IV. Process that takes place during the energizing of a chime circuit

(NOTE: This is a front door signal on a two note chime.)

- A. Button is pushed
    - 1. Circuit is completed to solenoid
    - 2. Plunger is drawn down to chime and sound is made
- B. Button is released
    - 1. Circuit is open
    - 2. Spring pulls plunger up to upper chime and another sound is made

V. Manual fan switching circuit (Transparency 3)

- A. Current from transformer goes to fan control switch
- B. Closed switch directs current to fan relay control coil

  (NOTE: This closes normally open contacts and the fan motor receives line voltage and runs.)
- C. Common conductor returns current to transformer

VI. Thermostat system switch in cool position, fan switch in automatic (Transparency 4)

- A. Current from transformer goes to mercury bulb switch
- B. From mercury switch current goes to the system switch
- C. Current splits at the system switch
    - 1. One split goes to fan switch
        - a. Through closed automatic contacts
        - b. To fan relay control coil

          (NOTE: This closes normally open relay contacts and starts fan motor.)
        - c. Back to transformer

INFORMATION SHEET

2. One split goes to the cooling contactor

   a. Through cooling contactor coil

      (NOTE: This closes normally open contacts and compressors starts.)

   b. Back to transformer

VII. System switch in heat position (Transparency 5)

A. Current from transformer goes to mercury bulb switch

B. Through mercury bulb switch to system switch

C. Through closed contacts of heat circuit

D. To heating contactor or control valve coil

(NOTE: This closes normally open relay contacts and energizes elements and low speed fan control. On gas models a plenum switch energizes fan motor.)

E. Back to transformer

VIII. Anticipator circuits

A. Heat and cool anticipators are installed to compensate for bimetallic lag

B. Cool anticipator

(NOTE: These are usually fixed resistors.)

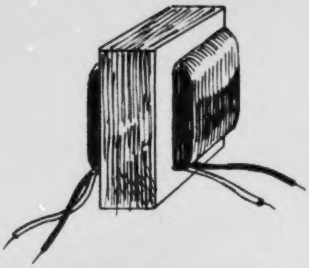
1. Wired parallel to mercury switch
2. Current draw through the resistor causes heat
3. Heat causes bimetal to tilt bulb and close circuit before room temperature actually reaches "on" temperature setting

C. Heat anticipator

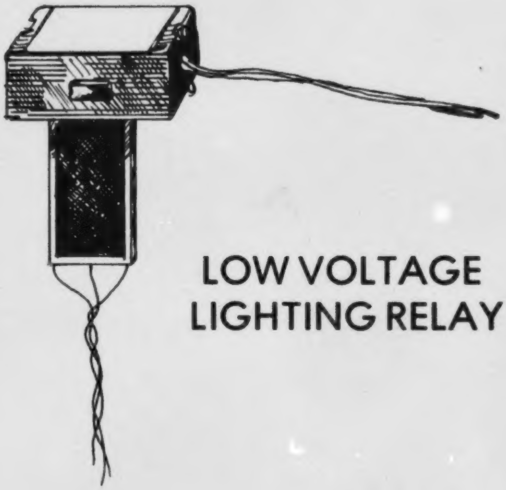
(NOTE: These are usually variable resistor.)

1. Wired in series with mercury switch
2. Current draw through switch causes heat
3. Heat causes bimetal to tilt bulb and open circuit when temperature reaches desired room setting

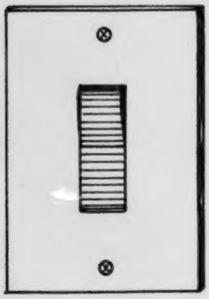
PARTS OF A LOW VOLTAGE LIGHTING SYSTEM



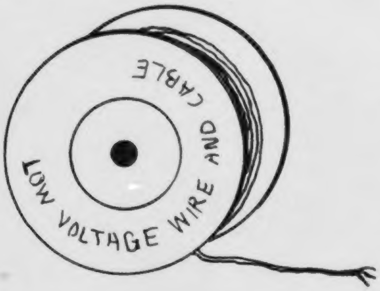
24 VOLT TRANSFORMER



LOW VOLTAGE
LIGHTING RELAY

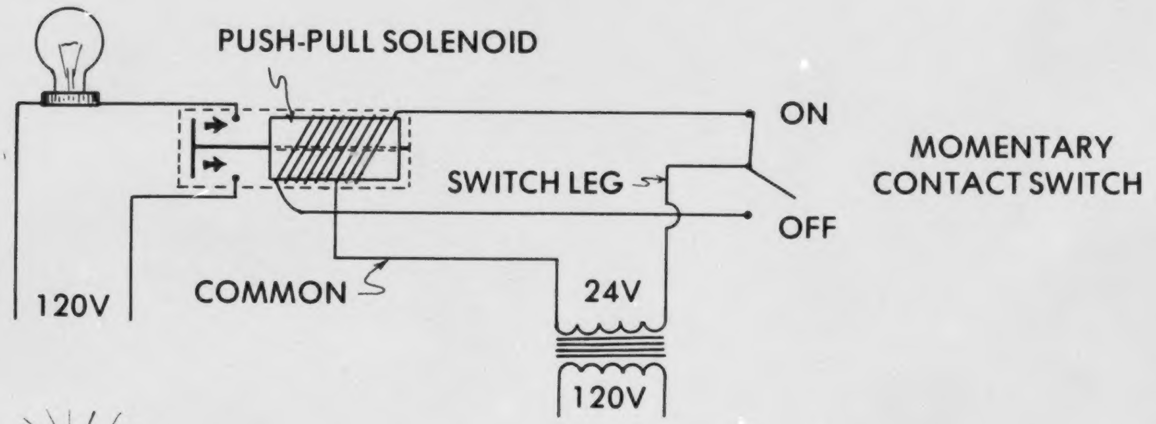


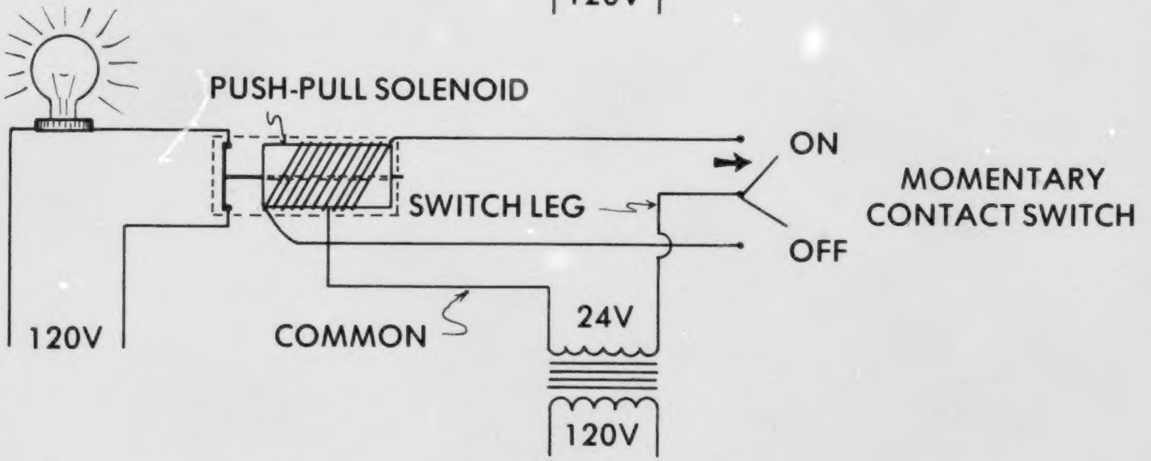
MOMENTARY CONTACT SWITCH

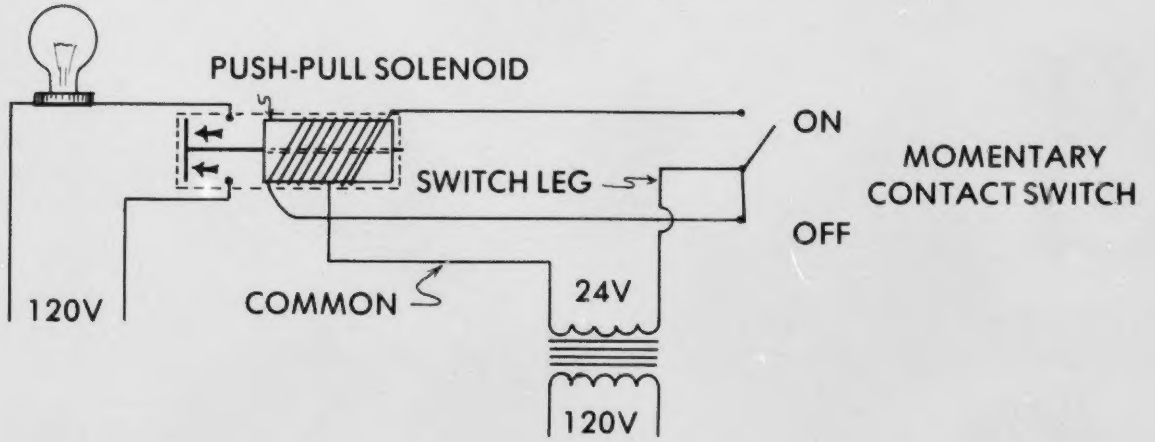

LOW VOLTAGE WIRE AND CABLE

LOW VOLTAGE CABLE

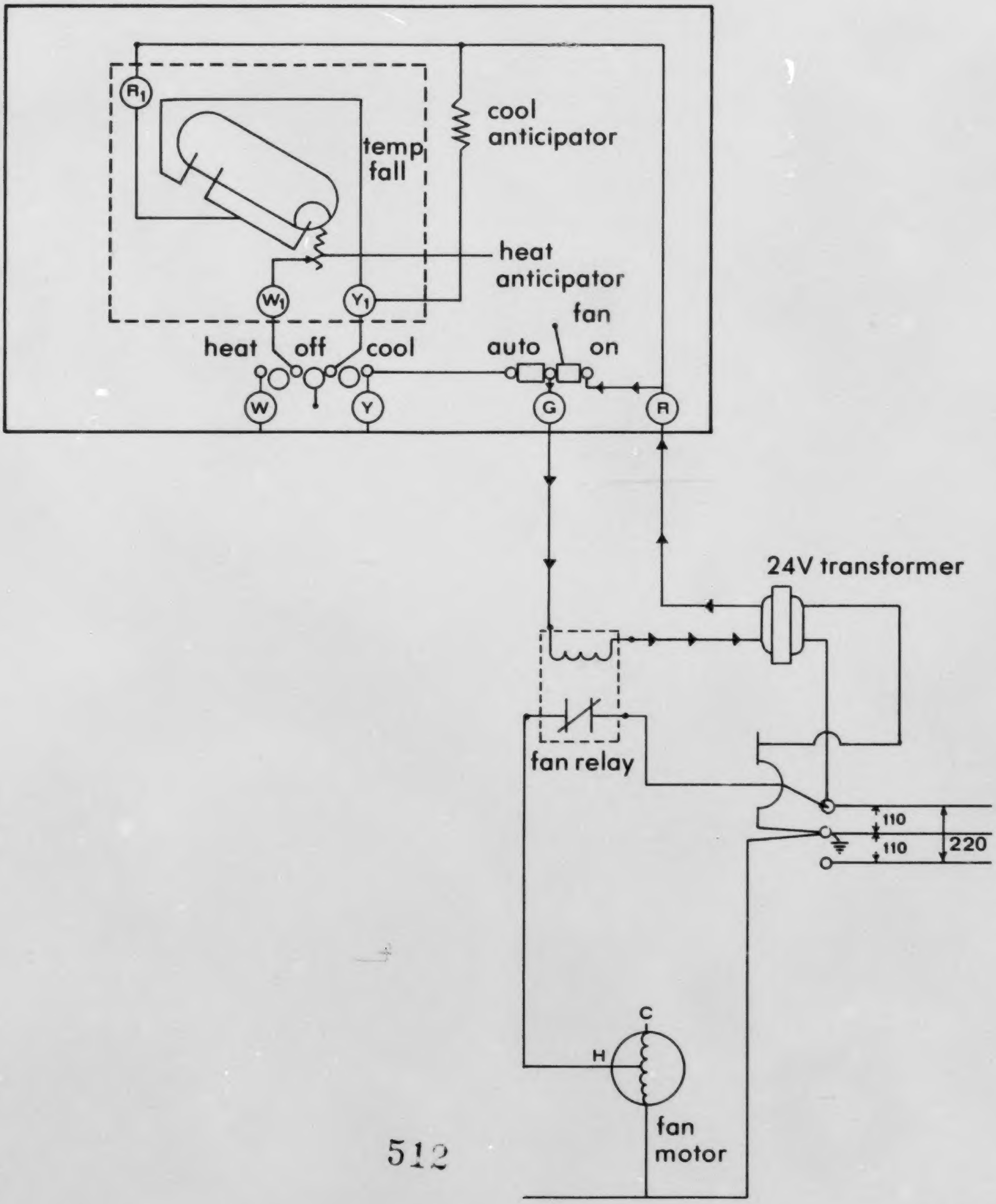
LOW VOLTAGE OFF/ON SWITCHING CYCLE


PUSH-PULL SOLENOID
ON
MOMENTARY CONTACT SWITCH
SWITCH LEG
OFF
COMMON
120V
24V
120V

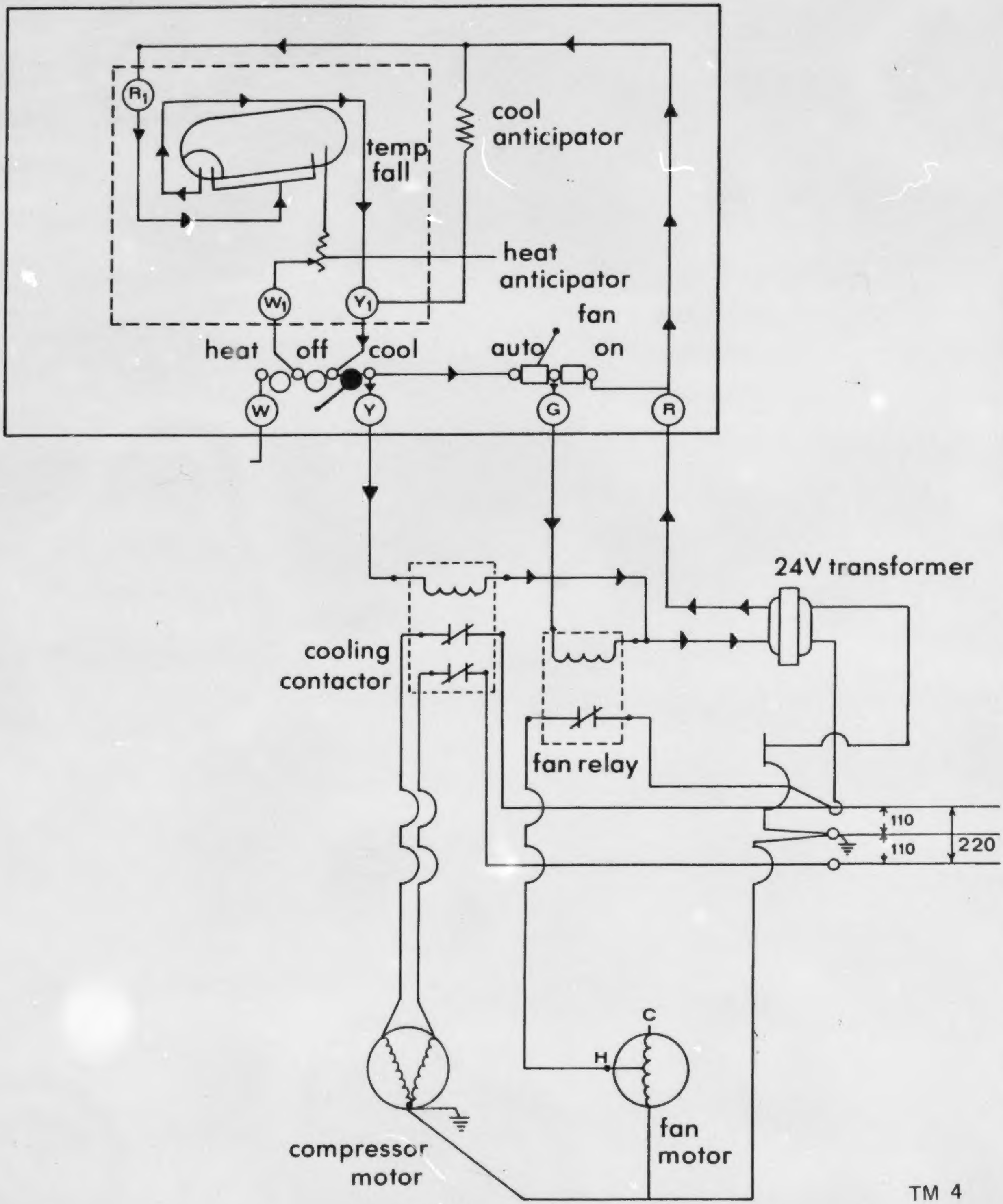

PUSH-PULL SOLENOID
ON
MOMENTARY CONTACT SWITCH
SWITCH LEG
OFF
COMMON
120V
24V
120V


PUSH-PULL SOLENOID
ON
MOMENTARY CONTACT SWITCH
SWITCH LEG
OFF
COMMON
120V
24V
120V

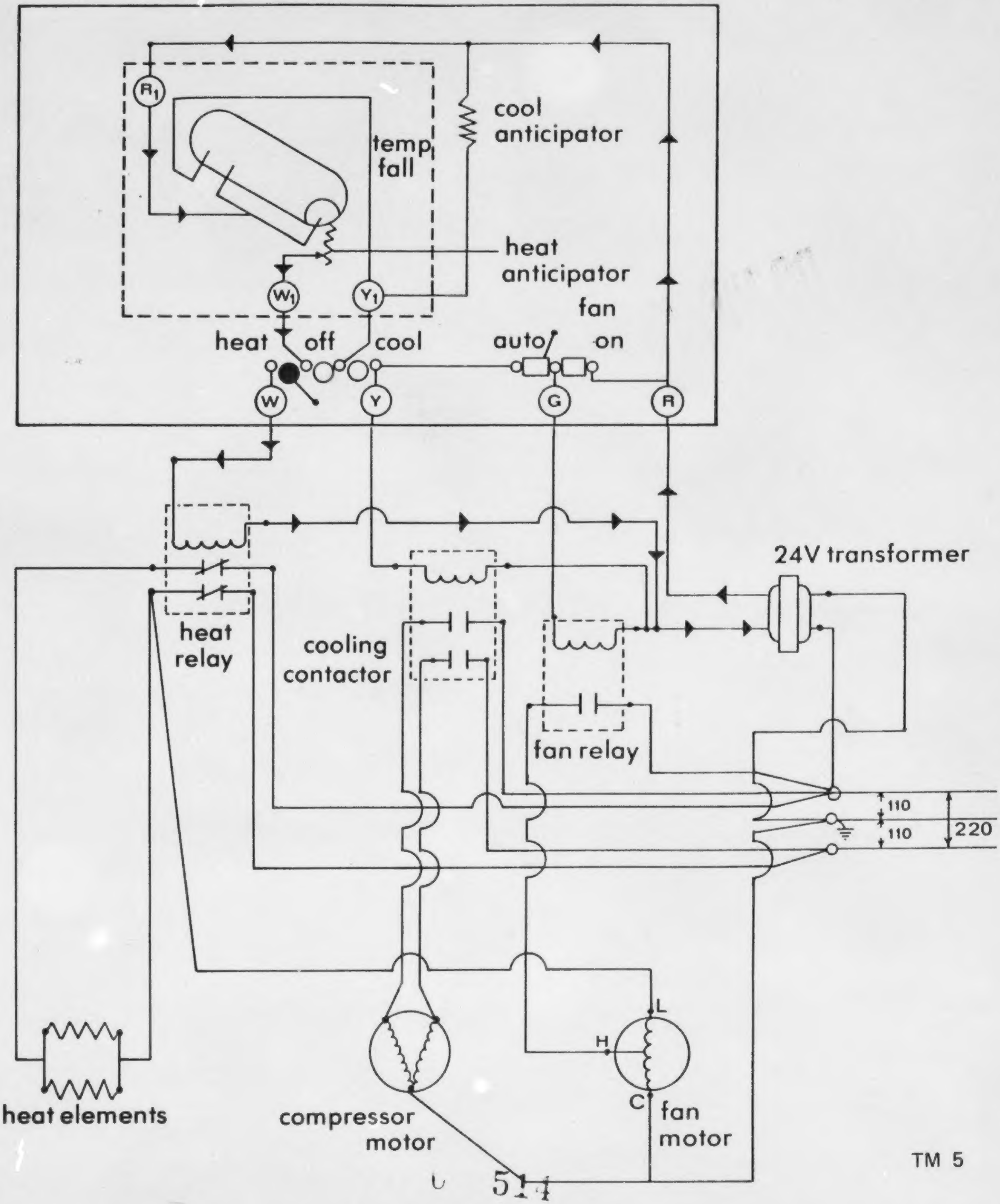
THERMOSTAT - - MANUAL FAN CONTROL


R1
temp fall
cool anticipator
heat anticipator
W1
Y1
fan
heat
off
cool
auto
on
W
Y
G
R
24V transformer
fan relay
110
110
220
C
H
fan motor

THERMOSTAT - -
COOLING CIRCUIT WITH AUTOMATIC FAN CONTROL


R1
cool anticipator
temp fall
heat anticipator
W1
Y1
fan
heat
off
cool
auto
on
W
Y
G
R
24V transformer
cooling contactor
fan relay
110
110
220
C
H
compressor motor
fan motor

THERMOSTAT - -
HEATING CIRCUIT WITH AUTOMATIC FAN CONTROL


R1
temp fall
cool anticipator
heat anticipator
W1
Y1
fan
heat
off
cool
auto
on
W
Y
G
R
24V transformer
heat relay
cooling contactor
fan relay
110
110
220
L
H
C
heat elements
compressor motor
fan motor

LOW VOLTAGE WIRING
UNIT VI

JOB SHEET #1--WIRE A TWO SWITCH LOW VOLTAGE LIGHTING CIRCUIT

I. Tools and equipment

A. 120-24v step down transformer

B. One 24v lighting relay

C. Two low voltage lighting switches

D. One octagon box and hanger

E. Two single gang plaster rings

(NOTE: Two regular device boxes could be used.)

F. Three wire low voltage cable

G. 12-2G or 14-2G NM cable

H. Wire connectors

I. Light socket

J. Incandescent bulb

K. Staples

L. 120v power supply

M. 2" x 4" mockup wall or shop board

N. Fasteners to secure boxes and hanger bar

O. Electrician's hammer

P. Flat blade screwdriver

Q. Lineman's pliers

R. Long nose pliers

S. Knife

T. Wire strippers

U. Drill motor and bit or brace

(NOTE: An extension cord will be needed if a drill motor is used.)

V. 1/2" or larger wood bit

JOB SHEET #1

W. Safety glasses

X. Portable GFI

II. Procedure

A. Put on safety glasses and gather tools and equipment

B. Mount box and plaster rings (Figure 1)

(NOTE: Use your GFI when drilling.)

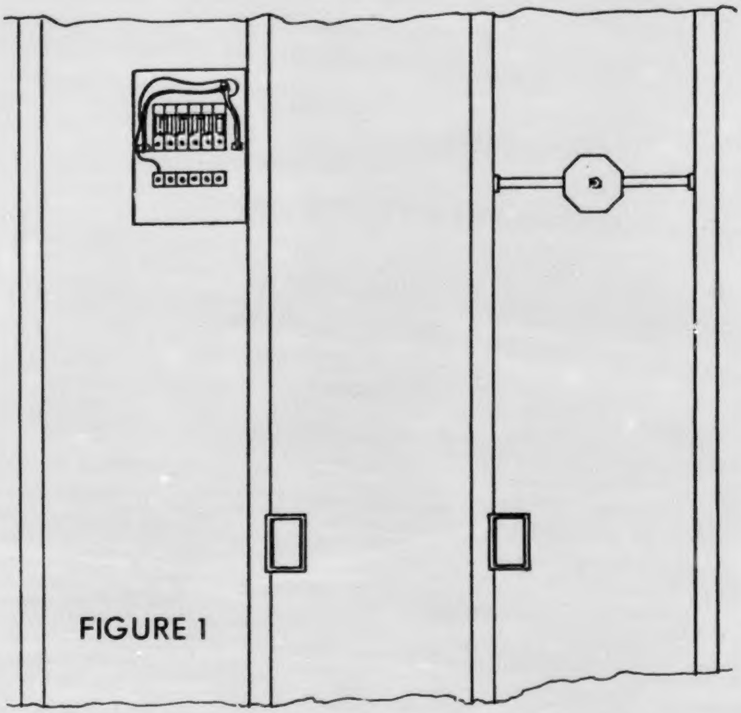


FIGURE 1

C. Run 120v supply cable from panel to lighting outlet box

(NOTE: In this example the transformer will be mounted at the outlet box; in a residence it must be accessible.)

D. Mount transformer on the back or top of outlet box

E. Install lighting relay

F. Drive the 16 penny nails in the center of the device ring openings at about the center of the stud

JOB SHEET #1

G. Run cable (Figure 2)

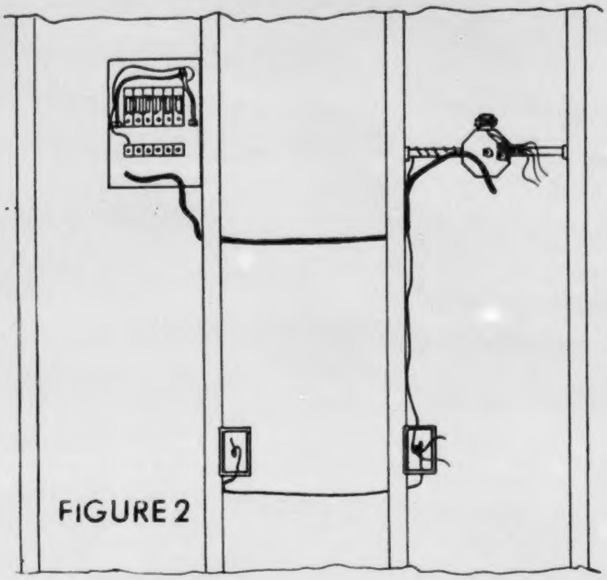


FIGURE 2

(NOTE: Wrap the cable around the bar hanger and around the nails.)

H. Make transformer and solenoid connections (Figure 3)

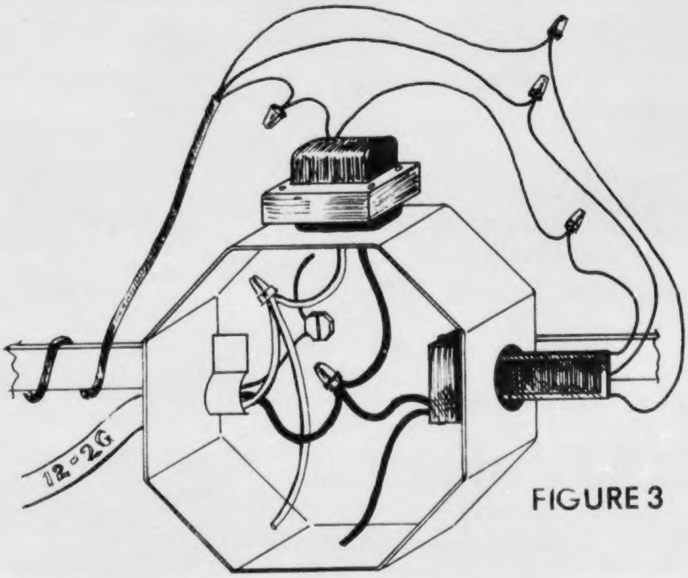


FIGURE 3

(NOTE: One transformer lead is the switch leg, and one transformer lead goes to relay common. The remaining two relay leads should be labeled as off and on return legs for switch connections.)

JOB SHEET #1

I. Connect switch leg to common on both switches

(NOTE: A pigtail is needed on the first connection to carry the switch leg to the second switch.)

J. Connect on and off return legs to appropriate switch terminals

K. Mount switches

L. Attach socket to neutral and relay 120 volt return leg

M. Make up panel (Figure 4)

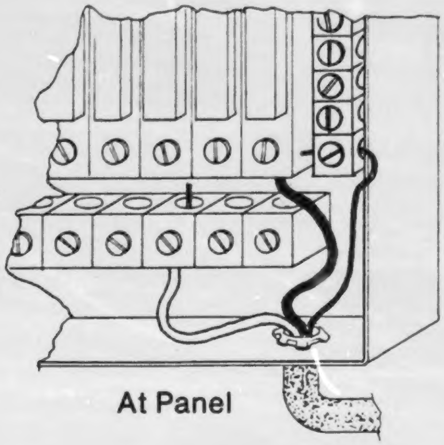


FIGURE 4

N. Turn on breaker

O. Turn on at one switch and off at the other

P. Turn on at other switch and off at the other

Q. Have your instructor evaluate this project

R. Turn off breaker

LOW VOLTAGE WIRING
UNIT VI

JOB SHEET #2--WIRE A TWO BUTTON CHIME CIRCUIT

I. Tools and equipment

   A. Two door bell buttons
   B. 18-3 and 18-2 bell wire cable
   C. 16 volt transformer
   D. Chime with front and back call
   E. 12 or 14-2G NM cable
   F. Electrician's hammer
   G. Long nose pliers
   H. Flat blade screwdriver
   I. Cable staples
   J. 3/8" cable clamp
   K. Stud wall or work board
   L. 120 volt power supply
   M. Pocket knife
   N. Wire strippers
   O. Wire connectors
   P. Octagon box and blank plate with 1/2" K.O.
   Q. 3/4" x 10" metal tapping screws
   R. Drill motor or brace
   S. 1/2" or larger wood bit
   T. Extension cord
   U. Header board (short piece of 1" x 6" or 2" x 4")
   V. Four 16 penny nails
   W. Safety glasses
   X. GFI

JOB SHEET #2

II. Procedure

A. Put on safety glasses and gather tools and equipment

B. Mount box (Figure 1)

(NOTE: If mounted on a wall plate this box must be above insulation. The best place to mount the transformer is a furnace closet so you can change it without getting in the attic.)

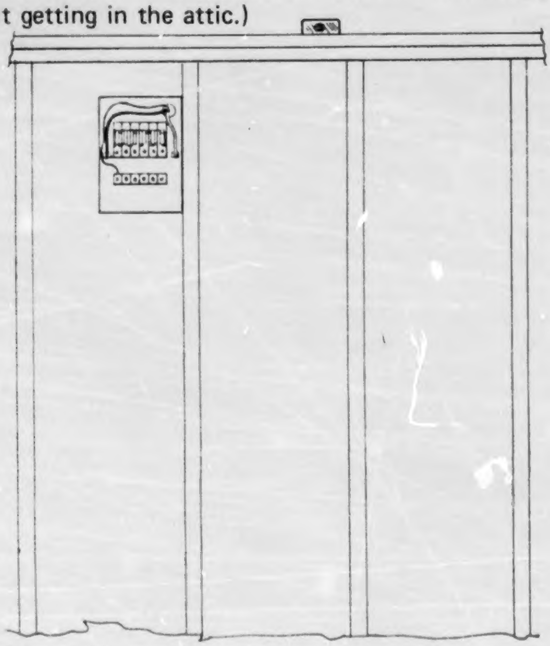


FIGURE 1

C. Mount header (Figure 2)

(NOTE: It must be mounted flush with wall surface.)

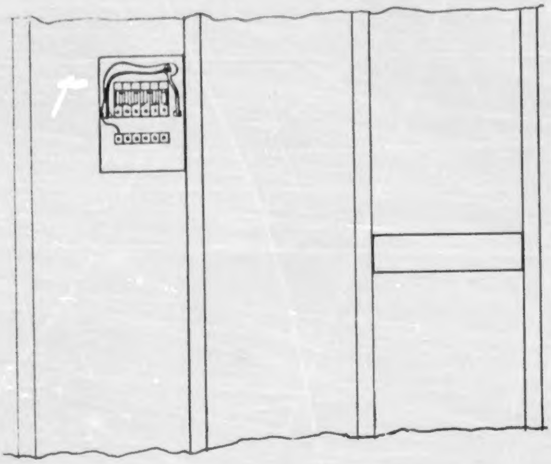


FIGURE 2

JOB SHEET #2

D. Drill holes (Figure 3)

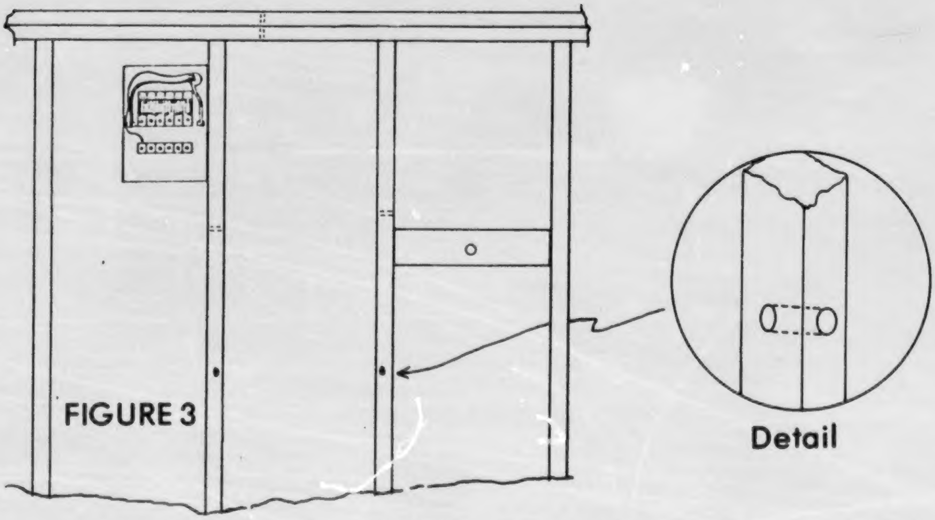


FIGURE 3

(NOTE: On a residential rough-in, button wires are drilled through at an angle in the door opening. Use GFI when drilling)

E. Run cable (Figure 4)

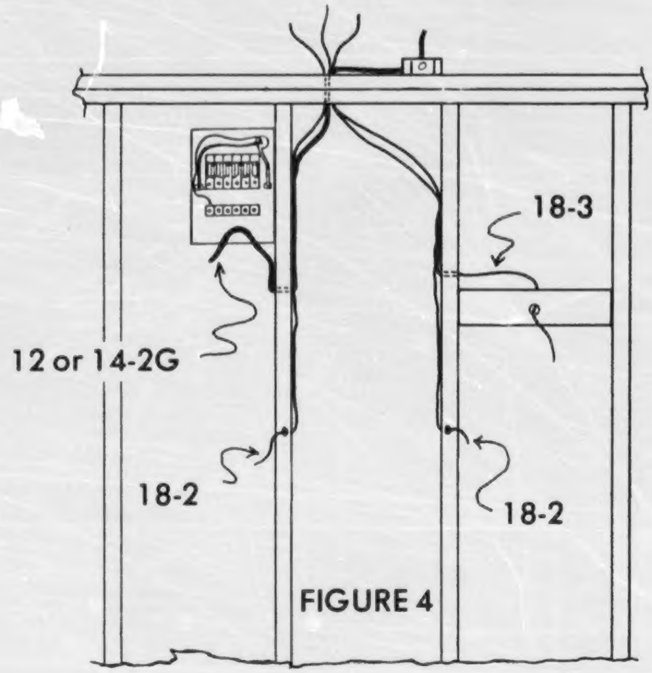

18-3
12 or 14-2G
18-2
18-2

FIGURE 4

JOB SHEET #2

F. Mount transformer to blank plate (Figure 5)

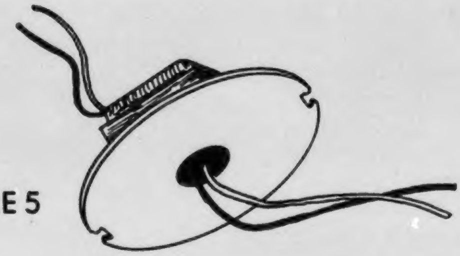


FIGURE 5

G. Connect transformer supply leads to cable from panel

H. Mount blank plate on octagon box

I. Make low voltage connections at transformer (Figure 6)

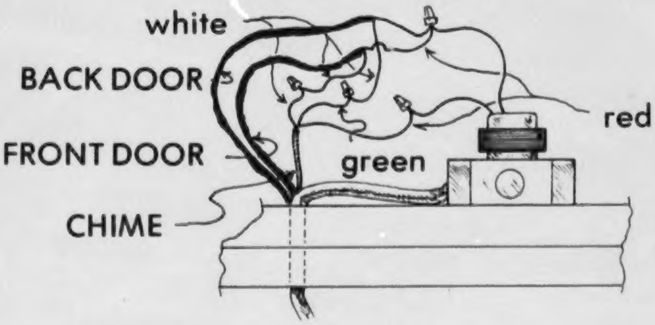

white
BACK DOOR
FRONT DOOR
CHIME
green
red

FIGURE 6

J. Mount chime on header

(NOTE: Put cable through opening in subbase before securing chime.)

K. Connect conductors to chime (Figure 7)

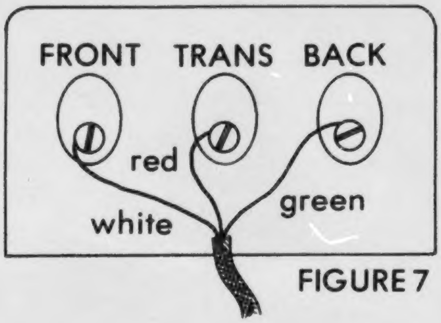

FRONT
TRANS
BACK
red
white
green

FIGURE 7

JOB SHEET #2

L. Connect buttons

M. Connect conductors at panel

N. Turn on breaker

O. Push front button

(NOTE: A two tone chime should be heard.)

P. Push back button

(NOTE: A one tone chime should be heard.)

Q. Have instructor evaluate work

R. Turn off breaker

LOW VOLTAGE WIRING
UNIT VI

JOB SHEET #3--DETERMINE HEAT ANTICIPATOR CURRENT DRAW

I. Tools and equipment

   A. Ammeter

   B. Coil of wire--10 loops

   C. Heating unit with 24v control

   D. Flat blade screwdriver

   E. Safety glasses

II. Procedure

   A. Disconnect power from heater

   B. Place coil of wire in series with one side of heating control (Figure 1)

   (NOTE: This may be either a gas valve or an electric relay.)

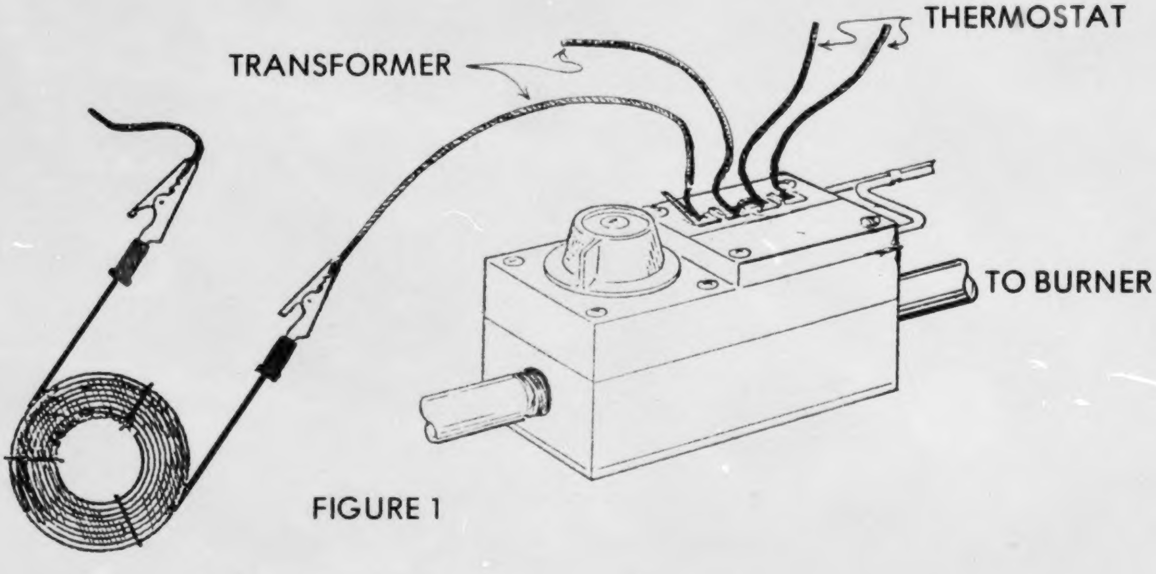


FIGURE 1

   C. Turn on power

   D. Increase thermostat setting above the ambient

JOB SHEET #3

E. Clamp ammeter through the coil of wire (Figure 2)

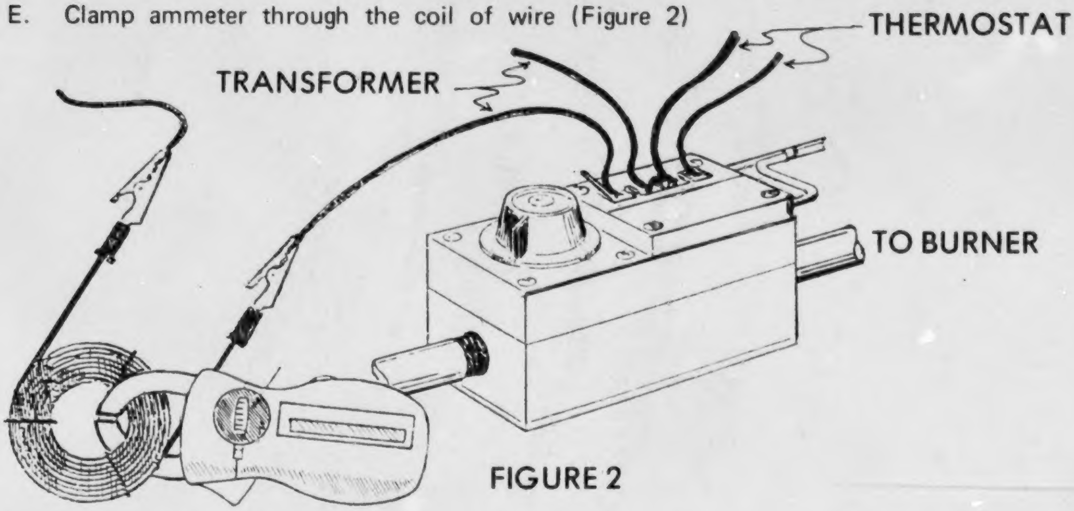

THERMOSTAT
TRANSFORMER
TO BURNER

FIGURE 2

F. Take ammeter reading

G. Divide the reading by ten

Example: Ammeter reading 4
$4 \div 10 = .4$

H. This is the anticipator setting

I. Set heat anticipator on thermostat (Figure 3)

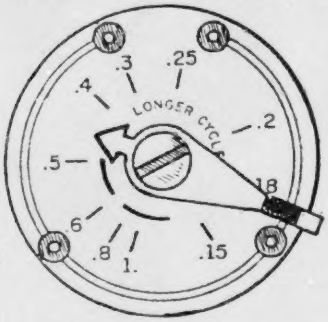

.3
.25
.4
LONGER CYCLE
.2
.5
.18
.6
.8
1.
.15

FIGURE 3

(NOTE: Most manufacturers of heating controls will print the ampere draw of the control on the side but in case it is not the above procedure may be used to determine it.)

J. Turn off heating unit

K. Disconnect electrical power

L. Have instructor check the anticipator setting

M. Clean up and put away tools

LOW VOLTAGE WIRING
UNIT VI

JOB SHEET #4--INSTALL A WALL THERMOSTAT

I. Tools and equipment

   A. Flat blade screwdriver

   B. Scratch awl

   C. Wire strippers

   D. Pocket screwdriver (small blade screwdriver)

   E. Heat-cool thermostat subbase

   F. Heat-cool thermostat

   G. Four conductor thermostat wire

   H. Level

   I. Safety glasses

II. Procedure

   A. Locate area on wall for thermostat

   B. Measure up from floor 54 to 60 inches

   C. Mark a spot to center subbase

   D. Hold subbase up to wall and center it

   E. Place level on subbase

   F. Check for approximate level

   G. Mark spots for mounting screws (Figure 1)

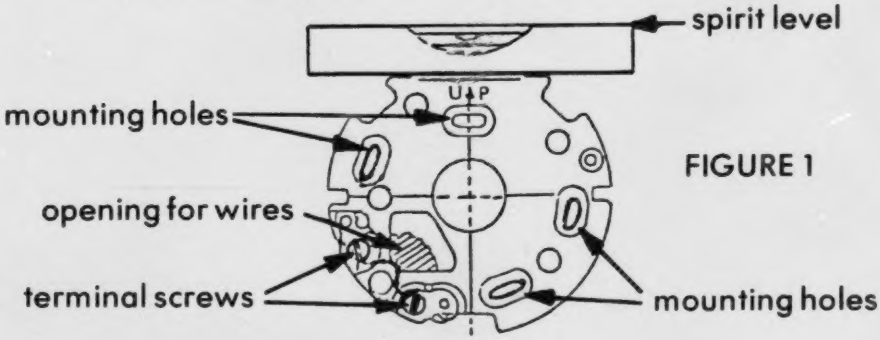

spirit level
UP
mounting holes
opening for wires
terminal screws
mounting holes

FIGURE 1

JOB SHEET #4

H. Mark spots in the center of the elongated slots

I. Move subbase

J. Use scratch awl to make screw holes

K. Place subbase on wall

L. Start screws

M. Check for level

N. Tighten screws and recheck level

O. Bring thermostat wire through the proper opening

(NOTE: Do not have any wires crossing the center of the subbase.)

P. Strip 1/2" of insulation off of each conductor

Q. Connect red wire to "R" or "V" terminal

R. Connect white wire to "W" or "H" terminal

S. Connect green wire to "G" or "F" terminal

T. Connect yellow wire to "Y" or "C" terminal

(NOTE: Some wire manufacturers have a blue wire instead of a yellow wire in their thermostat cable.)

U. Push the wires back to where they will not interfere with the thermostat

V. Have instructor check work

W. Align thermostat on subbase

(NOTE: Be sure thermostat is properly aligned before tightening to prevent cracking.)

X. Tighten thermostat screws

(NOTE: When removing a thermostat from a subbase leave the screws in the retainers in the thermostat.)

Y. Place cover on thermostat

(NOTE: If this is on a live system turn on power and check operation.)

Z. Clean up and put away tools and equipment

LOW VOLTAGE WIRING
UNIT VI

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

______a. A device that senses temperature variations from a set point and, in turn, acts to control a circuit

______b. Electromagnetic device for remote or automatic control

______c. Electromagnetic cylinder that will move an iron plunger when current is applied

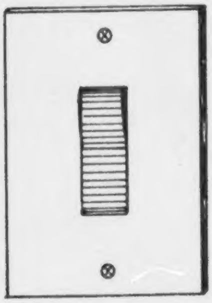
______d. Solenoid with two electromagnetic circuits that will pull or push a plunger depending on which magnet has current applied

______e. A switch that is closed or opened only while the operator touches it

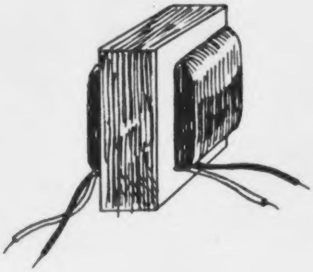
______f. An electrical device used to step up or step down a primary voltage to a desired secondary voltage

1. Transformer
2. Momentary contact switch
3. Solenoid
4. Relay
5. Thermostat
6. Pull-push solenoid

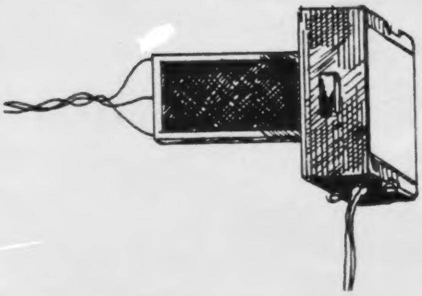
2. Identify the parts of a low voltage lighting system.



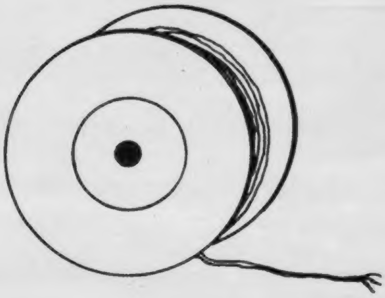
a. ___________ ___________



b. ___________ ___________



c. ____________ ____________

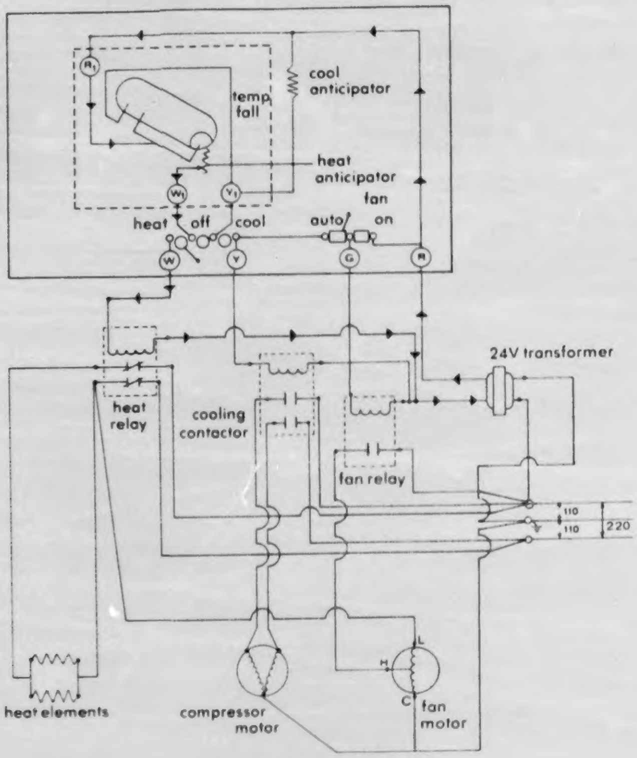


d. ____________ ____________

3. Describe the process that takes place during a low voltage lighting circuit off/on cycle.

4. Describe the process that takes place during the energizing of a chime circuit.

5. Describe the manual fan switching circuit, referring to the following illustration.


R1
temp fall
cool anticipator
heat anticipator
W1
Y1
fan
heat
off
cool
auto
on
W
Y
G
R
24V transformer
heat relay
cooling contactor
fan relay
110
110
220
heat elements
compressor motor
H
L
C
fan motor

6. Describe the circuit that is created when the thermostat system switch is in the cool position and the fan switch is in automatic. (Refer to the illustration in question 5)

7. Describe the circuit that is created when the system switch is in the heat position. (Refer to the illustration in question 5.)

8. Discuss anticipation circuits on low voltage thermostats.

9. Demonstrate the ability to:

   a. Wire a two switch low voltage lighting circuit.

   b. Wire a two button chime circuit.

   c. Determine heat anticipator current draw.

   d. Install a wall thermostat.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

LOW VOLTAGE WIRING
UNIT VI

ANSWERS TO TEST

1. a. 5 d. 6

   b. 4 e. 2

   c. 3 f. 1

2. a. Momentary contact switch

   b. 24 volt transformer

   c. Low voltage lighting relay

   d. Low voltage cable

3. Description should include:

   a. "On" switch is pushed

      1) Circuit is completed to closing movement of solenoid in relay

      2) Core is moved and circuit is completed

   b. "Off" switch is pushed

      1) Circuit is completed to opening movement of solenoid in relay

      2) Core is moved and circuit is opened

4. Description should include:

   a. Button is pushed

      1) Circuit is completed to solenoid

      2) Plunger is drawn down to chime and sound is made

   b. Button is released

      1) Circuit is open

      2) Spring pulls plunger up to upper chime and another sound is made

5. Description should include:
   - a. Current from transformer goes to fan control switch
   - b. Closed switch directs current to fan relay control coil
   - c. Common conductor returns current to transformer
6. Description should include:
   - a. Current from transformer goes to mercury bulb switch
   - b. From mercury switch current goes to the system switch
   - c. Current splits at the system switch
     - 1) One split goes to fan switch
       - a) Through closed automatic contacts
       - b) To fan relay control coil
       - c) Back to transformer
     - 2) One split goes to the cooling contactor
       - a) Through cooling contactor coil
       - b) Back to transformer
7. Description should include:
   - a. Current from transformer goes to mercury bulb switch
   - b. Through mercury bulb switch to system switch
   - c. Through closed contacts of heat circuit
   - d. To heating contactor or control valve coil
   - e. Back to transformer
8. Discussion should include:
   - a. Heat and cool anticipators are installed to compensate for bimetallic lag
   - b. Cool anticipator
     - 1) Wired parrallel to mercury switch
     - 2) Current draw through the resistor causes heat

        3) Heat causes bimetal to tilt bulb and close circuit before room temperature actually reaches "on" temperature setting

    c. Heat anticipator

        1) Wired in series with mercury switch

        2) Current draw through switch causes heat

        3) Heat causes bimetal to tilt bulb and open circuit when temperature reaches desired room setting

9. Performance skills evaluated to the satisfaction of the instructor

RESIDENTIAL SERVICE INSTALLATIONS
UNIT VII

UNIT OBJECTIVE

After completion of this unit, the student should be able to match service drop clearances to various construction locations, list minimum recommended sizes for service equipment, and state the maximum number of service disconnects allowed. The student should be able to discuss types of grounding electrodes and sizing and installation requirements for grounding electrode conductors. The student should also be able to identify the parts of a service entrance, calculate size of equipment needed, and demonstrate the ability to install a service entrance. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with service installations to the correct definitions.
2. Match the required clearances of service drop conductors to various construction locations.
3. State the maximum number of service entrance disconnects.
4. List the four facts that should be known before the service installation is started.
5. Identify the parts of a service entrance.
6. Discuss the various types of grounding electrodes.
7. Discuss grounding electrode conductor installations and sizes.
8. Calculate the size of service and minimum number of circuits required when given residence size and equipment to be installed.
9. Demonstrate the ability to:
    a. Install an overhead raceway with service entrance conductors to a meter base.
    b. Connect meter base assembly to load center or panel.

RESIDENTIAL SERVICE INSTALLATIONS
UNIT VII

SUGGESTED ACTIVITIES

I. Instructor:
   A. Provide student with objective sheet.
   B. Provide student with information, assignment and job sheets.
   C. Make transparencies.
   D. Discuss unit and specific objectives.
   E. Discuss information and assignment sheets.
   F. Demonstrate and discuss the procedures outlined in the job sheets.
   G. Discuss local and state code articles, if any.
   H. Consult your local utility company for their requirements.
   I. Give test.

II. Student:
   A. Read objective sheet.
   B. Study information sheet.
   C. Complete assignment and job sheets.
   D. Participate in group discussion.
   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   A. Objective sheet
   B. Information sheet
   C. Transparency masters
      1. TM 1--Parts of a Service Entrance
      2. TM 2--Parts of a Service Entrance (Continued)
      3. TM 3--Parts of a Service Entrance (Continued)

D. Assignment Sheet #1--Calculate Service Size and Minimum Number of Circuits

E. Answers to assignment sheet

F. Job sheets

   1. Job Sheet #1--Install an Overhead Raceway with Service Entrance Conductors to a Meter Base

   2. Job Sheet #2--Connect Meter Base Assembly to a Load Center or Panel

G. Test

H. Answers to test

II. Reference--*National Electrical Code,* 1981. Boston: National Fire Protection Association, 1980.

RESIDENTIAL SERVICE INSTALLATIONS
UNIT VII

INFORMATION SHEET

I. Terms and definitions

(NOTE: The majority of these definitions are from NEC Article 100.)

A. Service--Conductors and equipment for delivering energy from the electric supply system to the wiring system of the premises to be served

B. Service cable--Service conductors made up in the form of a cable

C. Service conductors--Supply conductors that extend from the street main or from transformers to the service equipment of the premises to be supplied

D. Service drop--Overhead service conductors from the last pole or other aerial support to and including the splices, if any, connecting to the service entrance conductors at the building or other structure

E. Service entrance conductors, underground system--Service conductors between the terminals of the service equipment and the point of connection to the service lateral

F. Service entrance conductors, overhead system--Service conductors between the terminals of the service equipment and a point usually outside the building, clear of building walls, where joined by tap or splice to the service drop

G. Service equipment--Necessary equipment, usually consisting of a circuit breaker or fuses and their accessories, located near the point of entrance of supply conductors to a building or other structure, or an otherwise defined area, and intended to constitute the main control and means of cutoff of the supply

(NOTE: Overcurrent devices shall not be located in the vicinity of easily ignitable material such as in clothes closets.)

H. Service lateral--Underground service conductors between the street main, including any risers at a pole or other structure or from transformers and the first point of connection to the service entrance conductors in a terminal box or meter or other enclosure with adequate space inside or outside the building wall

(NOTE: Where there is no terminal box, meter, or other enclosure with adequate space, the point of connection shall be considered to be the point of entrance of the service conductors into the building.)

I. Service raceway--Raceway that encloses the service entrance conductors

INFORMATION SHEET

J. Grounding electrode conductor--Conductor used to connect the grounding electrode to the equipment grounding conductor and/or the grounded conductor of the circuit at the service

K. Service mast--That portion of a service raceway that extends through a roof or eave

L. Roof flashing--Protective equipment used where the mast emerges from the roof or eave to seal around the raceway and protect against water damage

II. Clearances for service drop conductors not in excess of 600v

(NOTE: NEC Article 230 deals with services.)

A. Over roofs--Not less than 8' from highest point except where the voltage between conductors does not exceed 600 and:

1. If the roof has a slope of not less than 4" in 12", a 3' minimum is permitted on systems which do not exceed 300v between conductors

2. If the conductors do not pass over more than 4' of overhang and are terminated at a through-the-roof raceway or support an 18" miminum is permitted on systems which do not exceed 300v between conductors

B. From ground vertically

1. 10 feet--At the electric service entrance to buildings, or at the drip loop of the building electric entrance, measured from final grade or other accessible surface only for service-drop cables supported on and cabled together with a grounded bare messenger and limited to 150 volts to ground

2. 12 feet--For those areas listed in the 15 foot classification when the voltage is limited to 300 volts to ground

3. 15 feet--Over residential property and driveways, and those commercial areas not subject to truck traffic

4. 18 feet--Over public streets, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land traversed by vehicles such as cultivated, grazing, forest, and orchard

INFORMATION SHEET

III. Maximum number of service entrance disconnects--Not more than six switches or circuit breakers in single enclosure or grouped on a switchboard

(NOTE: NEC Article 230 deals with services. Where a residence requires more than six circuits, a main breaker is usually used.)

IV. Facts that should be known before the service installation is started

- A. Whether underground or overhead service will be used
- B. Voltage and amperage of service needed
- C. Point at which service conductors are to enter the building
- D. Size of service equipment needed

V. Service entrance (Transparencies 1, 2 and 3)

- A. Service entrance weatherhead or cap
- B. Service entrance raceway
- C. Service entrance conductors
- D. Hub
- E. Meter base
- F. Line lugs
- G. Load lugs
- H. Grounding lugs
- I. Underground service raceway
- J. Service mast
- K. Roof saddle
- L. Load center or panel
- M. Meter
- N. Grounding electrode conductor
- O. Service lateral

INFORMATION SHEET

VI. Types of grounding electrodes

(NOTE: NEC Article 250 deals with grounding.)

A. Structural metal--Nearest available effectively grounded structural metal member of the structure

B. Water pipe--Metal water pipe shall be used when available

(NOTE: It should be in direct contact with earth for 10 feet or more and electrically continous to the points of connection of the gounding electrode conductor and the bonding conductors.)

C. Made electrodes

1. At least 20' of #4 or larger bare copper or 1/2" or larger steel reinforcing bar encased in at least 2" of concrete in a footing

2. 8' lengths of:

a. 3/4" galvanized pipe

b. 5/8" iron or steel rod

c. 1/2" nonferrous rod (copper, brass, and other noncorrosive metals)

(NOTE: Where a rock bottom is not encountered the electrode shall be driven to a length of 8'. Where rock is hit at less than 4' the electrode shall be buried in a trench.)

3. At least 20' of #2 bare copper 2 1/2' undergrade encircling the structure

VII. Grounding electrode conductor installations and sizes

(NOTE: NEC Article 250 deals with grounding.)

A. Conductors and enclosures shall be secured to the surface they follow

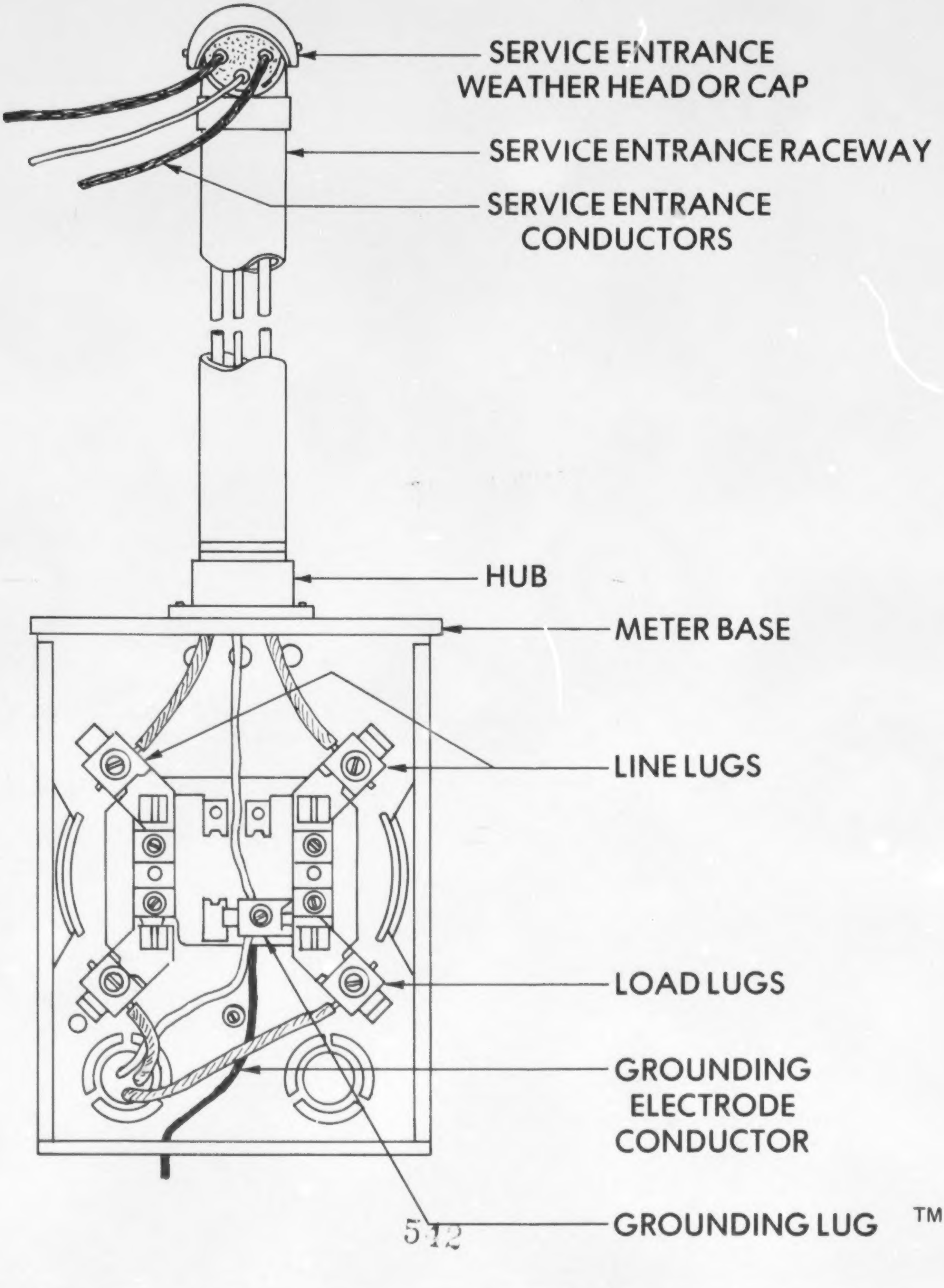
B. #6 or larger conductors

1. Must be in conduit if subject to physical damage

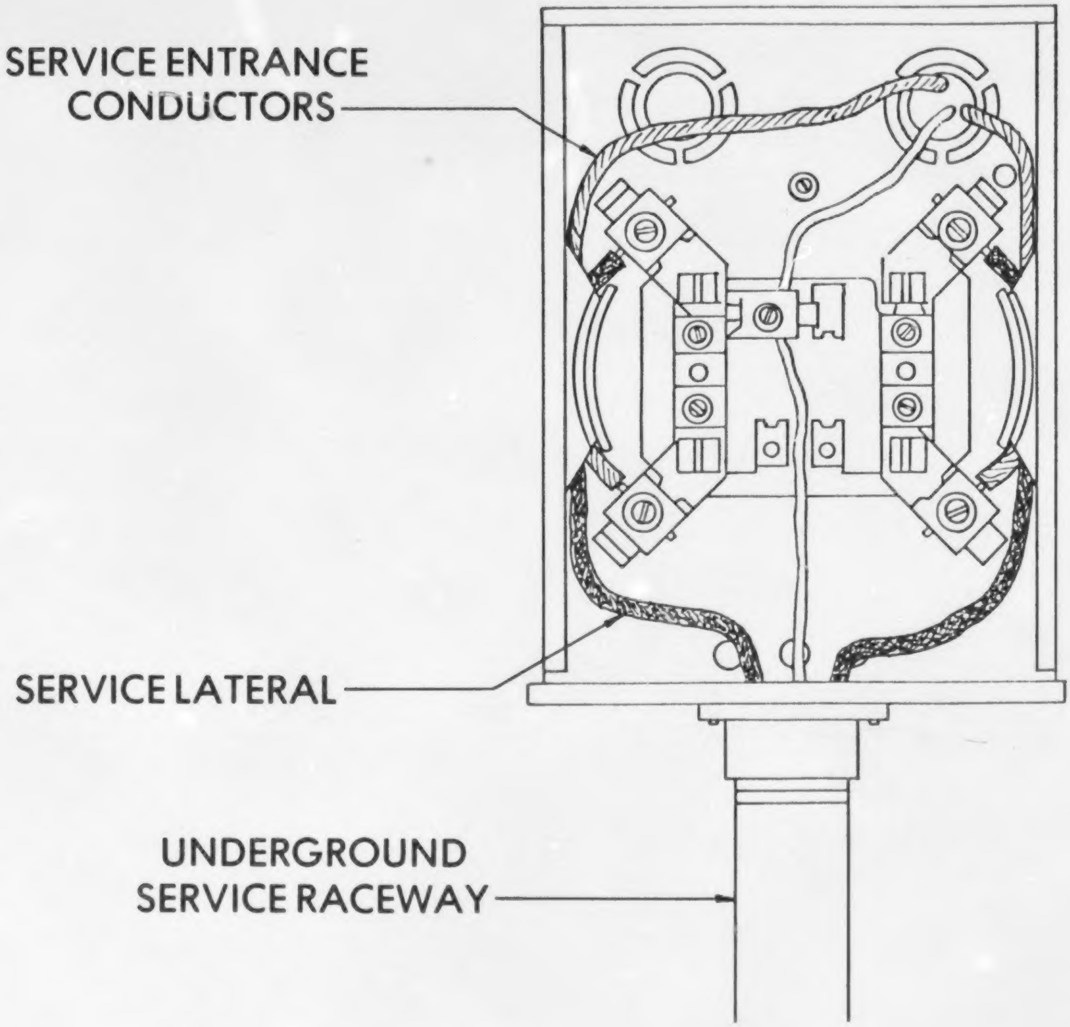
2. If free from physical damage it may follow the surface of building if stapled securely

3. Aluminum or copper clad aluminum cannot be used in contact with masonry or earth

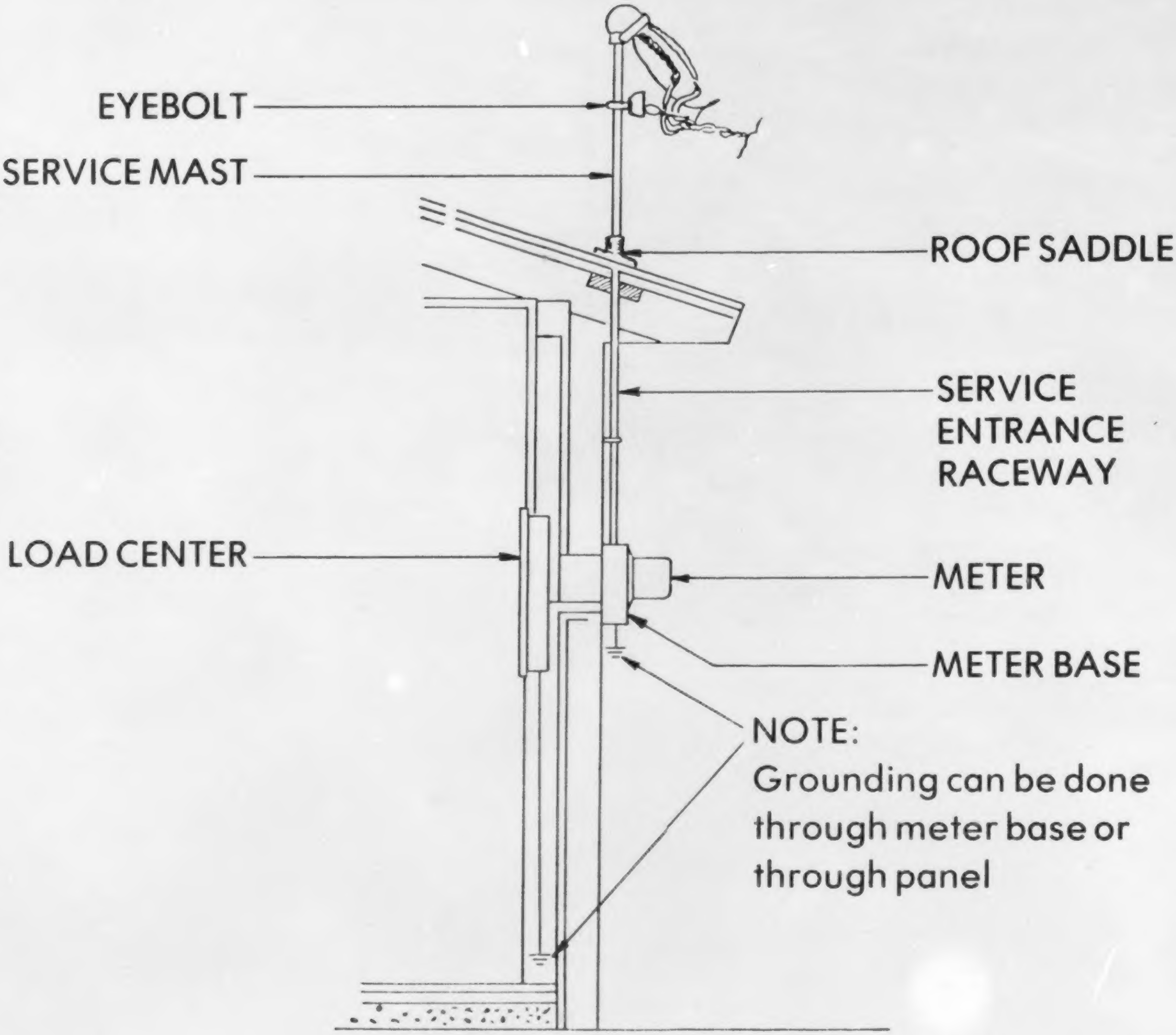
PARTS OF A SERVICE ENTRANCE


SERVICE ENTRANCE WEATHER HEAD OR CAP
SERVICE ENTRANCE RACEWAY
SERVICE ENTRANCE CONDUCTORS
HUB
METER BASE
LINE LUGS
LOAD LUGS
GROUNDING ELECTRODE CONDUCTOR
GROUNDING LUG

PARTS OF A SERVICE ENTRANCE
(continued)


SERVICE ENTRANCE
CONDUCTORS
SERVICE LATERAL
UNDERGROUND
SERVICE RACEWAY

PARTS OF A SERVICE ENTRANCE
(continued)


EYEBOLT
SERVICE MAST
ROOF SADDLE
SERVICE ENTRANCE RACEWAY
LOAD CENTER
METER
METER BASE

NOTE:
Grounding can be done through meter base or through panel

RESIDENTIAL SERVICE INSTALLATIONS
UNIT VII

ASSIGNMENT SHEET #1--CALCULATE SERVICE SIZE AND MINIMUM NUMBER OF CIRCUITS

Directions: Using the standard code procedure listed below calculate service size and minimum number of circuits on the following dwelling.

Dwelling has a floor space of 2,100 square feet. It also has an 11 kw electric range.

General lighting load
1. ________sq. ft. x 3 watts per sq. ft. = 2.________

Minimum number of branch circuits
General lighting load 3.________ ÷ 115 = 4.________ ÷ 20 = 5.________
or number of general lighting circuits

(NOTE: This number always rounds to next whole number if a fraction appears.)

Small appliance load: Two 2-wire 20 ampere circuits
Laundry load: One 2-wire 20 ampere circuit.

Minimum size feeders required
Computed load
General lighting 6.________ watts
Small appliance +3,000 watts
Laundry +1,500 watts
Total (without range) 7.________ watts

3,000 watts at 100% = 3,000 watts
Total (without range) 8.________ -3,000=
______ watts x 35% = 9.________ watts
Net computed load (without range) 10.________ watts

Range load 8,000 watts
Net computed load (with range) 11.________ watts

For 115/230 volt 2-wire system feeders, net computed load (with range) 12.________ ÷ 230 = 13.________ amperes

Net computed load exceeds 10 kw so service conductors shall be 100 amperes

Reduced size neutral shall be permitted, usually two trade sizes smaller than the ungrounded conductors

Feeder and service neutral
Lighting Small appliance load (net without range) 14.________ watts
Range load 8,000 watts at 70% 5,600 watts
Total 15.________ watts
Total 16.________ ÷ 230 = 17.________ amperes

(NOTE: NEC page 70-569 gives an example for future reference.)

RESIDENTIAL SERVICE INSTALLATIONS
UNIT VII

ANSWERS TO ASSIGNMENT SHEET

1. 2,100
2. 6,300
3. 6,300
4. 54.8
5. 3
6. 6,300
7. 10,800
8. 10,800
9. 2,730
10. 5,730
11. 13,730
12. 13,730
13. 59.7
14. 5,730
15. 11,330
16. 11,330
17. 49.3

RESIDENTIAL SERVICE INSTALLATIONS
UNIT VII

JOB SHEET #1--INSTALL AN OVERHEAD RACEWAY WITH SERVICE ENTRANCE CONDUCTORS TO A METER BASE

I. Tools and equipment

   A. Flat blade screwdriver

   B. Lineman's pliers

   C. Hammer

   D. Knife

   E. Hacksaw

   F. Folding rule with sliding scale

   G. Meter base

   H. Service entrance cap (1 1/2" clamp-on type)

   I. 3' of 1 1/2" rigid metal conduit (threaded on one end)

   J. 12' of #2 copper TW (two 6' pieces)

   K. 6' of #4 copper

   L. Safety glasses

II. Procedure

   A. Gather tools and equipment

   B. Screw threaded end of raceway into hub (Figure 1)

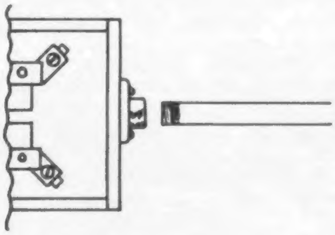


FIGURE 1.

JOB SHEET #1

C. Remove cover and separator from weatherhead (Figure 2)

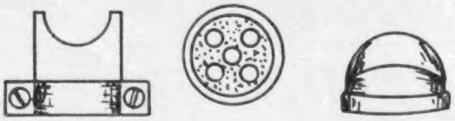


FIGURE 2.

D. Clamp weatherhead base onto the end of the service raceway (Figure 3)

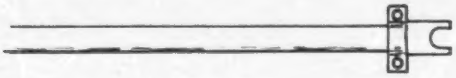


FIGURE 3.

E. Install conductors in the raceway

(NOTE: Start at weatherhead end.)

F. Connect grounded conductor to grounding lug

(NOTE: When possible leave grounded conductor long enough to connect to disconnect equipment grounding bar.)

G. Remove 1" to 1 1/2" of insulation from ungrounded conductors and connect to line lugs

H. Knock out three outlined holes in the entrance cap separator

I. Put grounded conductor through center hole

JOB SHEET #1

J. Put ungrounded conductors through side holes (Figure 4)

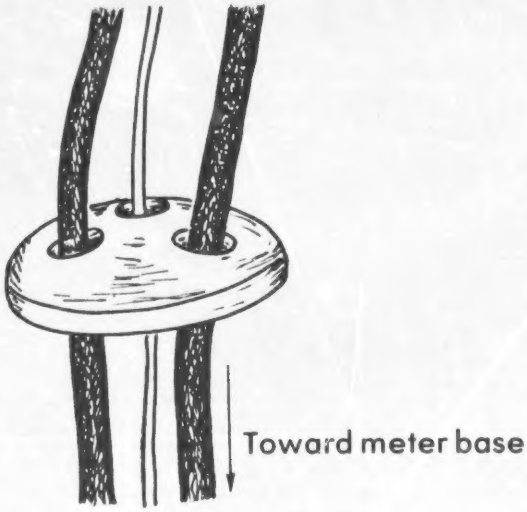


FIGURE 4.

K. Gently start forming conductors so the separator will fit back in the base

(NOTE: Care must be taken while you are bending the curvature in the conductors to prevent damage to the plastic conductor separator.)

L. Replace service entrance cap cover

RESIDENTIAL SERVICE INSTALLATIONS
UNIT VII

JOB SHEET #2--CONNECT METER BASE ASSEMBLY TO LOAD CENTER OR PANEL

I. Tools and equipment

A. Screwdriver

B. Lineman's pliers

C. Hammer

D. Knife

E. Level

F. Rule

G. Awl

H. Meter base assembly from Job Sheet #1

I. Two 1 1/4" insulating bushings

J. Four 1 1/4" locknuts

K. One 1 1/4 " reamed nipple long enough to connect meter base to distribution panel

(NOTE: Nipple, bushings and locknuts can be larger than 1 1/4" if conductor size or necessity mandates.)

L. #4 copper (1 piece)

M. #2 TW copper (2 pieces)

N. Eight 1" #12 metal tapping screws

O. One 100 amp 1 phase 3 wire SN. load center

P. One 1 1/2" rigid conduit strap

Q. 2" x 4" mock up wall or roughed in residential lling

R. Safety glasses

JOB SHEET #2

II. Procedure

A. Gather tools and equipment

B. Mount load center between studs with metal tapping screws

(NOTE: Panel height should be adjusted so that knockouts will line up with meter base between 5' and 6'. The utility company will give you their recommended height.)

C. Remove load center knockout that will align with meter base at correct height

D. Install nipple in opening with a locknut on the backside of load center and a locknut and bushing on the inside (Figure 1)

(NOTE: Be sure that locknuts are installed tightly with teeth into the metal. Also be sure to check local codes on bonding.)

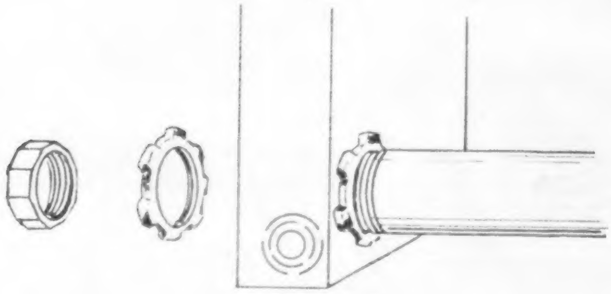


FIGURE 1.

E. Remove appropriate knockout from meter base

F. Put back up locknut for meter base on nipple

JOB SHEET #2

G. Place nipple through meter base knockout and secure loosely with one screw (Figure 2)

(NOTE: Cut off excess nipple, leave only what is needed for locknut and bushing.)

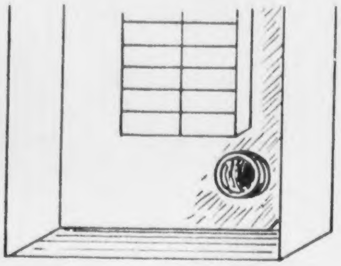


FIGURE 2.

H. Install internal locknut and bushing

I. Place level on side of meter base and secure with mounting screws when leveled (Figure 3)

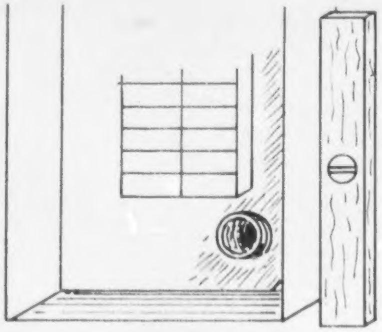


FIGURE 3.

J. Put level on service raceway and secure with strap when leveled

JOB SHEET #2

K. Install grounded conductor in nipple and connect to meter base and load center grounded lugs

(NOTE: Make all bends in conductors as square as possible while maintaining a radius equal to at least five times the diameter. Make sure you stay as far as possible from load and line lugs in your routing of the grounded conductors.)

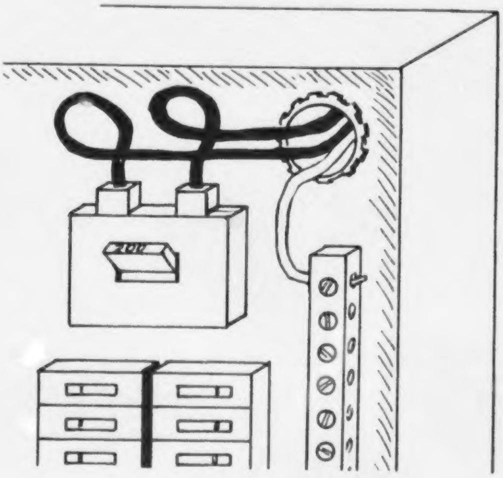
L. Install ungrounded conductors in nipple

M. Strip about 1 1/2" insulation from each of the ungrounded conductors, form them and connect to meter load lugs

N. Form ungrounded conductors in load center

O. Cut off excess and connect to load center line lugs (Figure 4)

FIGURE 4.



(NOTE: The service system is still without a grounding electrode conductor. This conductor can originate at the load center, or in the meter base. It can terminate at a cold water pipe or made electrode.)

RESIDENTIAL SERVICE INSTALLATIONS
UNIT VII

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Conductors and equipment for delivering energy from the electric supply system to the wiring system of the premises to be served

_____b. Service conductors between the terminals of the service equipment and the point of connection to the service lateral

_____c. Underground service conductors between the street main, including any risers at a pole or other structure or from transformers and the first point of connection to the service entrance conductors in a terminal box or meter or other enclosure with adequate space inside or outside the building wall

_____d. That portion of a service raceway that extends through a roof or eave

_____e. Raceway that encloses the service entrance conductors

_____f. Supply conductors that extend from the street main or from transformers to the service equipment of the premises to be supplied

_____g. Service conductors between the terminals of the service equipment and a point usually outside the building, clear of building walls, where joined by tap or splice to the service drop

_____h. Service conductors made up in the form of a cable

1. Service
2. Service cable
3. Service conductors
4. Service drop
5. Service entrance conductors; underground system
6. Service entrance conductors; overhead system
7. Service equipment
8. Service lateral
9. Service raceway
10. Grounding electrode conductor
11. Service mast
12. Roof flashing

______i. Conductor used to connect the grounding electrode to the equipment grounding conductor and/or to the grounded conductor of the circuit at the service

______j. Protective equipment used where the mast emerges from the roof or eave to seal around the raceway and protect against water damage

______k. Necessary equipment, usually consisting of a circuit breaker or fuses and their accessories, located near the point of entrance of supply conductors to a building or other structure, or an otherwise defined area, and intended to constitute the main control and means of cut off of the supply

______l. Overhead service conductors from the last pole or other aerial support to and including the splices, if any, connecting to the service entrance conductors at the building or other structure

2. Match the required clearances of service drop conductors on the right to the various construction locations.

______a. Above grade, sidewalks and platforms or projections

______b. Over a roof with a slope of not less than 4" in 12" on systems which do not exceed 300V between conductors

______c. Over commercial areas subject to truck traffic

______d. Over public streets, alleys, roads, and nonresidential driveways

______e. If the conductors do not pass over more than 4' of overhang and are terminated at a through-the-roof raceway or support on a system which does not exceed 300v between conductors

______f. Over residential driveways, and commercial areas not subject to truck traffic

1. 3'
2. 18"
3. 10'
4. 12'
5. 15'

3. State the maximum number of service entrance disconnects.

4. List four facts that should be known before the service installation is started.

   a.

   b.

   c.

   d.

5. Identify the parts of a service entrance.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

i. ____________________

j. ____________________

k. ____________________

l. ____________________

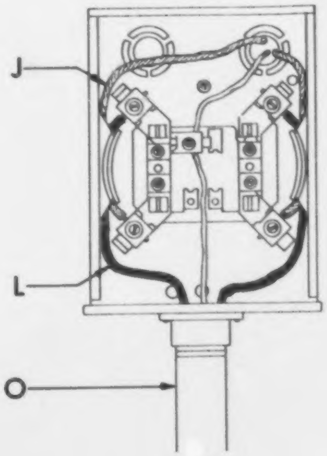
m. ____________________

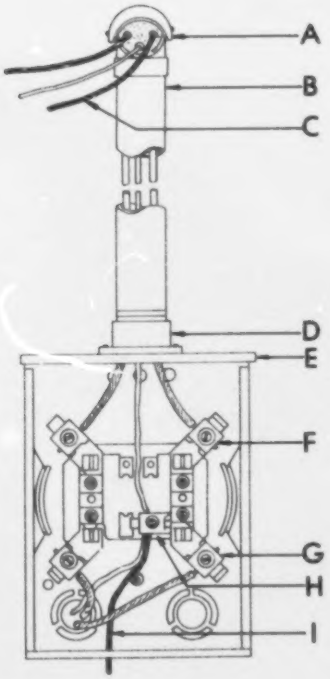
n. ____________________

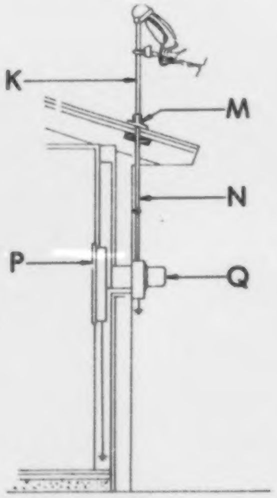
o. ____________________

p. ____________________

q. ____________________







6. Discuss various types of grounding electrodes.

7. Discuss grounding electrode conductor installations and sizes.

8. Calculate the size of service and minimum number of circuits on the following dwelling.

1,900 sq. ft. with a 12 kw range

General lighting load
a.__________sq. ft. x 3 watts per sq. ft. = b.__________

Minimum number of branch circuits
General lighting load c.__________ ÷ 115 = d.__________ ÷ 20 =
e.__________ or number of general lighting circuits

Small appliance load: Two 2-wire 20 ampere circuits.
Laundry load: One 2-wire 20 ampere circuit.

Minimum size feeders required
Computed load

General lighting	f.__________watts
Small appliance	+3,000 watts
Laundry	+1,500 watts
Total (without range)	g.__________watts
3,000 watts at 100% =	3,000 watts
Total (without range) h.__________ - 3,000=	
_____watts x 35% =	i.__________watts
Net computed load (without range)	j.__________watts
Range load	+8,000 watts
Net computed load (with range)	K.__________watts

For 115/230 volt 3-wire system feeders, net computed load (with range.) l. ____________ ÷ 230 = m. ____________amperes

Net computed load exceeds 10 kw so service conductors shall be 100 amperes

Reduced size neutral shall be permitted, usually two trade sizes smaller then the ungrounded conductors

Feeder and service neutral
Lighting: Small appliance load (net without range) n. ____________watts
Range load 8,000 watts at 70% +5,600 watts
Total o. ____________watts

Total p. ____________ ÷ 230 = q. ____________amperes

9. Demonstrate the ability to:

   a. Install an overhead raceway with service entrance conductors to a meter base.

   b. Connect meter base assembly to load center or panel.

   (NOTE: If the above activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

RESIDENTIAL SERVICE INSTALLATIONS
UNIT VII

ANSWERS TO TEST

1. a. 1
   b. 5
   c. 8
   d. 11
   e. 9
   f. 3
   g. 6
   h. 2
   i. 10
   j. 12
   k. 7
   l. 4

2. a. 3
   b. 1
   c. 5
   d. 6
   e. 2
   f. 4

3. Not more than six switches or circuit breakers in a single enclosure or grouped on a switchboard (NEC Article 230)

4. a. Whether underground or overhead service will be used
   b. Voltage and amperage of service needed
   c. Point at which service conductors are to enter the building
   d. Size of service equipment needed

5. a. Service entrance weatherhead or cap
   b. Services entrance raceway
   c. Service entrance conductors
   d. Hub
   e. Meter base
   f. Line lugs

g. Load lugs

h. Grounding lugs

i. Grounding electrode conductor

j. Service entrance conductors

k. Service mast

l. Service lateral

m. Roof saddle

n. Service entrance raceway

o. Underground service raceway

p. Load center or panel

q. Meter

6. Discussion should include:

   a. Water pipe--Metal water pipe shall be used when available

   b. Made electrodes

      1. 20' or #4 bare copper or 1/2" or larger steel reinforcing bar encased in at least 2" of concrete in a footing

      2. 8' lengths of:

         a. 3/4" galvanized pipe

         b. 5/8" iron or steel rod

         c. 1/2" nonferrous rod (copper, brass, and other noncorrosive metals)

7. Discussion should include:

   a. Conductors and enclosures shall be secured to the surface they follow

   b. #6 or larger conductors

      1. Must be in conduit if subject to physical damage

      2. If free from physical damage it may follow the surface of the building if stapled securely.

      3. Aluminum or copper clad aluminum cannot be used in contact with masonry or earth

8.
   - a. 1,900
   - b. 5,700
   - c, 5,700
   - d. 49.6
   - e. 3
   - f. 5,700
   - g. 10,200
   - h. 10,200
   - i. 2,520
   - j. 5,520
   - k. 13,520
   - l. 13,520
   - m. 58.8
   - n. 5,520
   - o. 11,120
   - p. 11,120
   - q. 48.3

9. Performance skills evaluated to the satisfaction of the instructor

TRIM OUT
UNIT VIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to trim out a residential dwelling. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with appliance connections to the correct definitions.
2. Match common residential appliances to their classification as fixed, portable, or stationary.
3. State one acceptable disconnecting means for each classification of appliance.
4. Select times when noncurrent carrying metal parts of fixed equipment shall be grounded.
5. List basic procedures for connecting appliances.
6. Demonstrate the ability to:
    a. Connect a supply cord to a garbage disposal.
    b. Connect a supply cord to a free standing range.
    c. Install a fixed appliance equipped with a pigtail to a branch circuit.
    d. Install plates on devices.

TRIM OUT
UNIT VIII

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and job sheets.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Review Articles 210, 422, 430, and 440 in the NEC.

   H. Discuss different design features on fixtures and how they are installed.

   I. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Review Articles 210, 422, 430, and 440 in the NEC.

   E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Job sheets

      1. Job Sheet #1--Connect a Supply Cord to a Garbage Disposal

      2. Job Sheet #2--Connect a Supply Cord to a Free Standing Range

3. Job Sheet #3--Install a Fixed Appliance Equipped With a Pigtail to a Branch Circuit

4. Job Sheet #4--Install Plates on Devices

E. Test

F. Answers to test

II. Reference--National Electrical Code, 1981. Boston: National Fire Protection Association, 1980.

TRIM OUT
UNIT VIII

INFORMATION SHEET

I. Terms and definitions

  A. Appliance--Utilization equipment, generally other than industrial, normally built in standardized sizes or types, which is installed or connected as a unit to perform one or more functions such as clothes washing, air conditioning, food mixing, or deep frying

  B. Appliance branch circuit--A branch circuit supplying energy to one or more outlets to which appliances are to be connected; such circuits to have no permanently connected lighting fixtures not a part of an appliance

  C. Individual branch circuit--Branch circuit that supplies only one piece of utilization equipment

  D. Disconnecting means--A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply

  E. Volt ampere--Voltage multiplied times amperage

  F. Trim out--Final stage in a residential wiring project; involves devices and plates, connecting and securing equipment, hanging fixtures, and testing the system

II. Classification of common residential appliances

  A. Fixed

    1. Garbage disposal

    2. Cooking top

    3. Drop in range

    4. Built in oven

INFORMATION SHEET

        5. Air conditioner
        6. Water heater
        7. Dishwasher

    B. Portable

        1. Food mixer
        2. Electric skillet
        3. Toaster
        4. Small electric heater

    C. Stationary

        1. Free standing range
        2. Washer
        3. Dryer
        4. Refrigerator

III. Disconnecting means for classifications of appliances

    A. Fixed appliances--Branch circuit breaker

    (NOTE: The code requires this disconnect to be readily accessible to the appliance user if the load is over 300 VA or 1/8 HP.)

    B. Portable appliances--Separable connector or attachment plug and receptacle

    (NOTE: Article 422 of the NEC lists construction requirements for receptacles and caps used for this purpose.)

    C. Stationary appliances--Separable connector or attachment plug and receptacle

IV. Times when noncurrent carrying metal parts of fixed equipment shall be grounded

    A. Within eight feet vertically or five feet horizontally of ground or grounded objects and possible contact by persons

    B. In damp and wet locations and not isolated

    C. In electrical contact with metal

INFORMATION SHEET

D. In hazardous locations

E. If fed by metal enclosed wiring

(NOTE: This does not apply if less than 25 feet long and isolated as per article 250.)

F. When voltage exceeds 150 volts to ground

V. Basic procedures for connecting appliances

A. Match branch circuit ampacity to appliance requirements

(NOTE: The requirements for the different classes of appliances including maximum overcurrent protection can be found in the NEC.)

B. Meet disconnect requirements

C. Ground the appliance as required by the code

D. Do all work in a professional manner

E. Be safety conscious

(NOTE: Be conscious about your own safety while doing a job that will insure the safety of the appliance user.)

TRIM OUT
UNIT VIII

JOB SHEET #1--CONNECT A SUPPLY CORD TO A GARBAGE DISPOSAL

I. Tools and equipment

  A. Screwdriver

  B. Wire strippers

  C. Wire nuts

  D. Appropriate appliance cord

  (NOTE: Cord must be acceptable to the NEC and local code enforcing agent.)

  E. Small fixed appliance

  F. Safety glasses

II. Procedure

  A. Gather tools and equipment and put on safety glasses

  B. Locate appliance manufacturer's specification plate

  C. Compare appliance specifications to cord selected

  (NOTE: Be sure the cord will reach the outlet you plan on using.)

  D. Remove access plate from appliance (Figure 1)

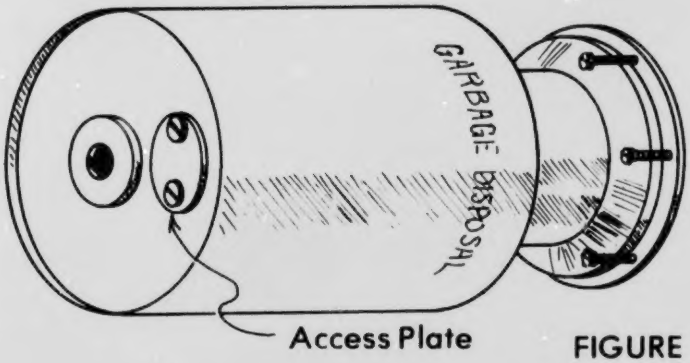


FIGURE 1

JOB SHEET #1

E. Install cable connector

F. Connect cord conductors to appropriate appliance terminals or conductors.

G. Adjust cord inside unit

(NOTE: Make sure all conductors are free moving and not cramped.)

H. Tighten cable connector

(NOTE: Don't overtighten and cut the cord.)

I. Replace access plate

(NOTE: If an equipment grounding plug is not provided inside the unit termination space, you can add a grounding terminal.)

J. Plug unit into appropriate receptacle

(NOTE: Be sure and plug it into the switched receptacle.)

K. Test appliance for correct operation

(NOTE: You should have water running into the disposal as you test it.)

TRIM OUT
UNIT VIII

JOB SHEET #2--CONNECT A SUPPLY CORD TO A FREE STANDING RANGE

I. Tools and equipment

  A. Screwdriver

  B. Appropriate appliance cord

  (NOTE: Cord must be acceptable to the NEC and local code enforcing agent.)

  C. Free standing range

  D. Nut driver set

  E. Safety glasses

II. Procedures

  A. Gather tools and equipment and put on safety glasses

  B. Position range in best possible working position

  C. Remove appliance terminal cover plate (Figure 1)

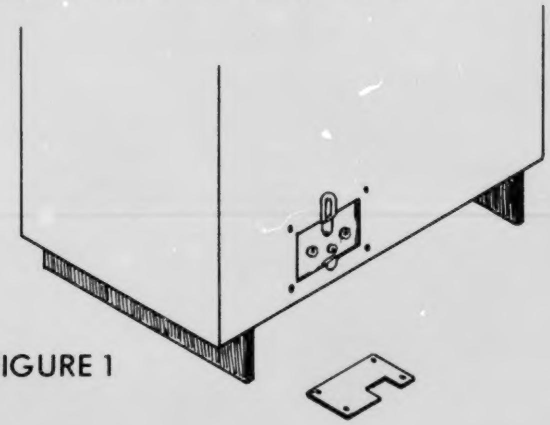


FIGURE 1

  D. Install cord securing equipment

  (NOTE: Most range cord sets have a clamp included with the cord)

  E. Connect ungrounded conductors to appropriate terminals

  F. Connect equipment grounding conductor

  (NOTE: The frame of the range may be grounded to the grounded circuit conductor, providing it is not smaller than a No. 10 copper.)

JOB SHEET #2

G. Check cord conductors

(NOTE: Conductors should be arranged so that a pull on the cord will put tension on the cord connector, not the appliance terminals.)

H. Replace cover plate

I. Plug in appliance

J. Check appliance for correct operation

(NOTE: Be sure and remove all tape and packing from the oven before testing. Level the oven before you leave.)

TRIM OUT
UNIT VIII

JOB SHEET #3--INSTALL A FIXED APPLIANCE EQUIPPED WITH A PIGTAIL TO A BRANCH CIRCUIT

I. Tools and equipment

A. Box and cover

(NOTE: Be sure box has a capacity rating to accommodate the conductors being used.)

B. Fixed appliance with pigtail

C. Connectors

(NOTE: The pigtail may have a greenfield connector already on it. AC able connector will probably be needed if not internal with the box.)

D. 2 #12 x 1" MTS screws

E. Wire connectors

(NOTE: Wire nuts, crimp sleeves and tape or any other code approved method are acceptable.)

F. Screwdriver

G. Pocket knife

H. Wire strippers

I. Safety glasses

II. Procedure

(NOTE: Be sure that the branch circuit you are working around is not hot.)

A. Gather tools and materials and put on safety glasses

B. Determine box location

(NOTE: Be sure and place the box in a location close enough to make the connection to the appliance pigtail.)

C. Mount the box

(NOTE: Be sure the box will not interfere with the installation of the appliance.)

D. Install branch circuit conductors in the box

JOB SHEET #3

E. Position the appliance so the pigtail will reach the box

F. Connect appliance pigtail to box (Figure 1)

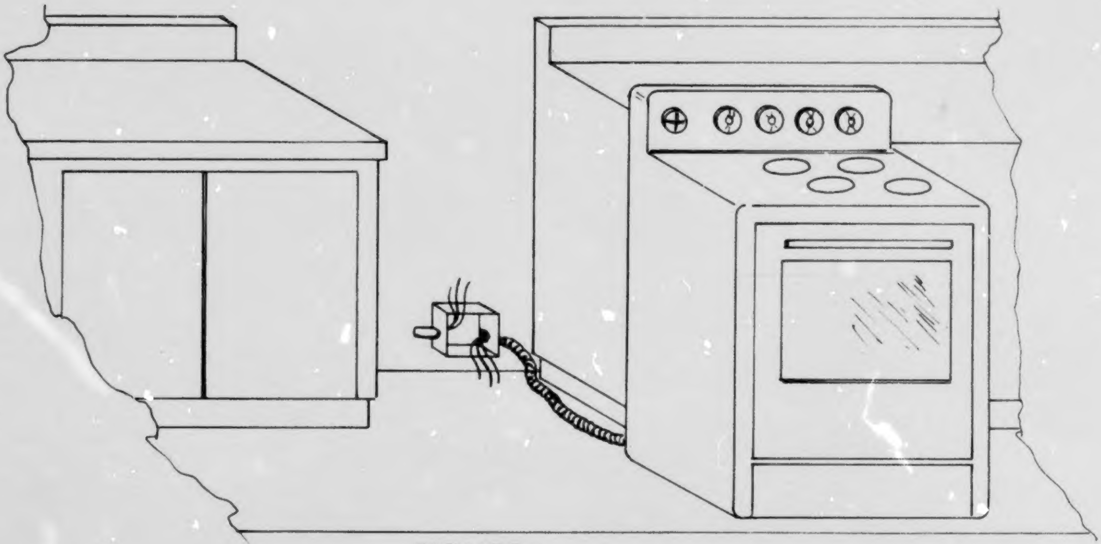


FIGURE 1

G. Splice appliance supply conductors to branch circuit conductors

(NOTE: Be sure and make mechanically secure connections.)

H. Install cover plate on box

I. Position appliance for securing

J. Activate circuit and check appliance

K. Rest appliance in its correct position

(NOTE: Make sure the pigtail is not in a bind.)

L. Secure and level appliance

M. Clean up area

TRIM OUT
UNIT VIII

JOB SHEET #4--INSTALL PLATES ON DEVICES

I. Tools and equipment

  A. Screwdriver

  B. Plates

  C. Safety glasses

  D. Device installation ready for trim out

  E. AWI

  F. Tap tool

II. Procedure

  A. Gather tools and equipment and put on safety glasses

  B. Square up the device or devices (Figure 1)

  (NOTE: The slots for the device securing screws are elongated to allow straightening of the device even if the box is not straight.)

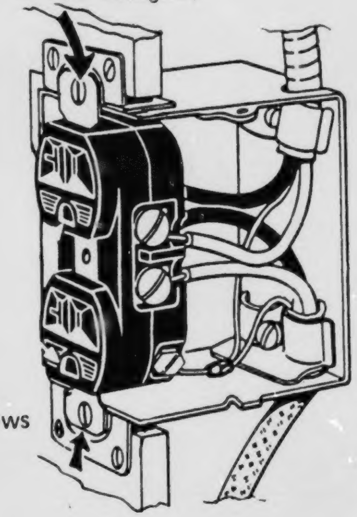


FIGURE 1

    1. Single device

      a. Loosen device mounting screws

      b. Hold plate over device

      c. Turn until straight

      (NOTE: The device should turn with the plate if it is flush installed.)

JOB SHEET #4

2. Multiple devices

   a. Loosen device mounting screws

   b. Hold plate over devices

   c. Level up plate

   d. Line up plate securing screws with awl

   (NOTE: If you have a lot of multiple device plates to install, a straightening jig can be made to level up the plates and secure the devices in one step. See Figure 2.)

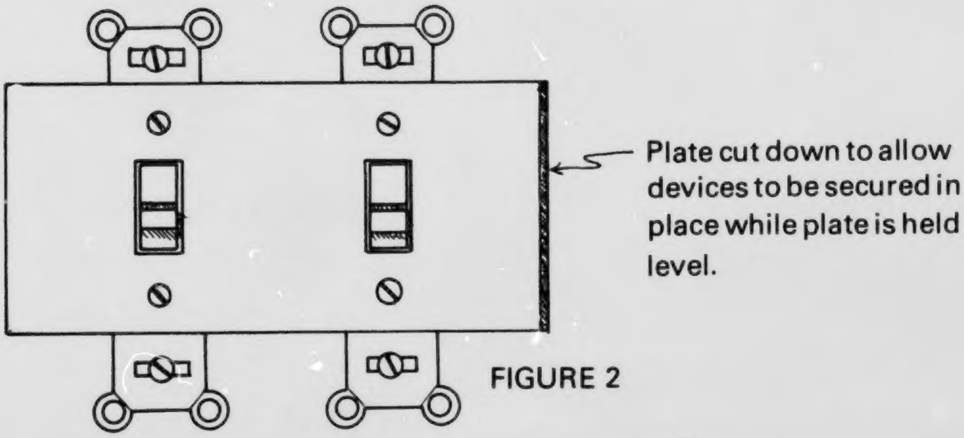


Plate cut down to allow devices to be secured in place while plate is held level.

FIGURE 2

C. Remove plate

D. Tighten device securing screws

E. Reinstall plate

   (NOTE: Check to make sure everything is square.)

F. Install plate securing screws

   (NOTE: Be careful not to overtighten and crack the plate.)

TRIM OUT
UNIT VIII

NAME ______________________________

TEST

1. Match the terms on the right with the correct definitions.

______a. Utilization equipment, generally other than industrial, normally built in standardized sizes or types, which is installed or connected as a unit to perform one or more functions such as clothes washing, air conditioning, food mixing, or deep frying

______b. A branch circuit supplying energy to one or more outlets to which appliances are to be connected; such circuits to have no permanently connected lighting fixtures not a part of an appliance

______c. Branch circuit that supplies only one piece of utilization equipment

______d. A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply

______e. Voltage multiplied times amperage

______f. Final stage in a residential wiring project; involves installing devices and plates, connecting and securing equipment, hanging fixtures and testing the system

1. Disconnecting means
2. Individual branch circuit
3. Volt ampere
4. Appliance
5. Appliance branch circuit
6. Trim out

2. Match the types of appliances on the right to the common residential appliances on the left.

______a. Drop in range

______b. Washer

______c. Air conditioner

______d. Small electric heater

______e. Food mixer

______f. Garbage disposal

______g. Water heater

______h. Free standing range

______i. Cooking top

______j. Built in oven

______k. Dryer

______l. Electric skillet

______m. Toaster

______n. Dishwasher

______o. Refrigerator

1. Fixed
2. Portable
3. Stationary

3. State one acceptable disconnecting means for each classification of appliance.

a. Fixed appliances--

b. Portable appliances--

c. Stationary appliances--

4. Select times when noncurrent carrying metal parts of fixed equipment shall be grounded by placing an "X" in the appropriate blanks.

______a. Within eight feet vertically or five feet horizontally of ground or grounded objects and possible contact by persons

______b. In damp and wet locations and not so isolated

______c. In electrical contact with metal ______d. In hazardous locations

______e. If fed by metal enclosed wiring

______f. When voltage exceeds 150 volts to ground

5. List the basic procedures for connecting appliances.

   a.

   b.

   c.

   d.

   e.

6. Demonstrate the ability to:

   a. Connect a supply cord to a garbage disposal.

   b. Connect a supply cord to a free standing range.

   c. Install a fixed appliance equipped with a pigtail to a branch circuit.

   d. Install plates on devices.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

TRIM OUT
UNIT VIII

ANSWERS TO TEST

1. a. 4
   b. 5
   c. 2
   d. 1
   e. 3
   f. 6

2. a. 1
   b. 3
   c. 1
   d. 2
   e. 2
   f. 1
   g. 1
   h. 3
   i. 1
   j. 1
   k. 3
   l. 2
   m. 2
   n. 1
   o. 3

3. a. Fixed appliances--Branch circuit breaker
   b. Portable appliances--Separable connector or attachment plug and receptacle
   c. Stationary appliances--Separable connector or attachment plug and receptacle

4. a, b, c, d, e, f

5. a. Match branch circuit ampacity to appliance requirements
   b. Meet disconnect requirements
   c. Ground the appliance as required by the code
   d. Do all work in a professional manner
   e. Be safety conscious

6. Performance skills evaluated to the satisfaction of the instructor

CABLE INSTALLATIONS
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to install cables in existing dwellings. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with cable installations to the correct definitions.
2. Identify construction members common in existing residential dwellings.
3. List four common routes for new cable installations in existing dwellings.
4. List possible methods for getting cable through or around construction members.
5. Demonstrate the ability to:
    a. Install cable between an existing box and a newly installed box horizontally along a wall in a channel behind baseboard.
    b. Install cable between an existing box and a newly installed box using an underfloor crawl space.
    c. Install cable between an existing box and a newly installed box using attic space.

CABLE INSTALLATIONS
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and job sheets.

   F. Demonstrate and discuss the procedures outlined in the job sheets.

   G. Discuss fishing techniques in two story houses.

   H. Take a field trip to a remodeled or old house with exposed construction members.

   I. Give test.

II. Student

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Construction Members

      2. TM 2--Construction Members (Continued)

   3. TM 3--Common Routes For New Cable Installations
   4. TM 4--Common Routes For New Cable Installations (Continued)
   5. TM 5--Working Past Fireblocks
   6. TM 6--Working Past Fireblocks (Continued)

D. Job sheets

   1. Job Sheet #1--Install Cable Between an Existing Box and a Newly Installed Box Horizontally Along a Wall in a Channel Behind Baseboard
   2. Job Sheet #2--Install Cable Between an Existing Box and a Newly Installed Box Using an Underfloor Crawl Space
   3. Job Sheet #3--Install Cable between an Existing Box and a Newly Installed Box Using Attic Space

E. Test

F. Answers to test

II. References:

A. Herrick, Clyde. *Residential Electrical Wiring.* Santa Monica, California: Goodyear Publishing Company, Inc. 1976.

B. *National Electrical Code,* 1981. Boston: National Fire Protection Association, 1980.

CABLE INSTALLATIONS
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Fish--Establishing a connection between two points so a cable can be installed

   B. Channel--Groove formed in materials

   C. Underfloor crawl space--Working space underneath the house

   D. Drop cloth--Cloth or covering used to catch chips or dust

   E. Fish wire--Length of wire with a hook formed in one end to catch materials being installed in a space

II. Construction members (Transparencies 1 and 2)

   A. Fireblock

   B. Header

   C. Sill

   D. First floor joists

   E. Plate

   F. Studs

   G. Brace

   H. Sleeper wall

   I. Rafter

   J. Ridge board

   K. Top plate

   L. Ceiling joists

   M. Floor board

   N. Bridging

   O. Sub floor

   P. Bottom plate (sole plate)

INFORMATION SHEET

- Q. Girder
- R. Pier block
- S. Girder post
- T. Pier
- U. Foundation wall
- V. Footing

III. Routes for cable installations in existing dwellings (Transparencies 3 and 4)

- A. Vertically in a wall
- B. Horizontally in a channel behind baseboard
- C. Horizontally in underfloor crawl space
- D. Horizontally in an attic

IV. Possible methods for getting cable through or around construction members

(NOTE: Good electricians can think their way around almost anything.)

- A. Top plates
    1. Straight drilling
    2. Angle drilling
    3. Lifting a shingle and drilling
    4. Over top plate and back through insulation board inside eave

       (NOTE: Select the method which is easiest and causes the least structural boring or changing to make a safe professional installation.)
- B. Bottom plates (sole plate)
    1. Top drilling behind baseboard
    2. Bottom drilling

       (NOTE: This is the preferred method due to the time involved in removal and reinstallation of baseboard.)

INFORMATION SHEET

C. Fire blocks

1. Lifting shingle and top drilling through block with extension

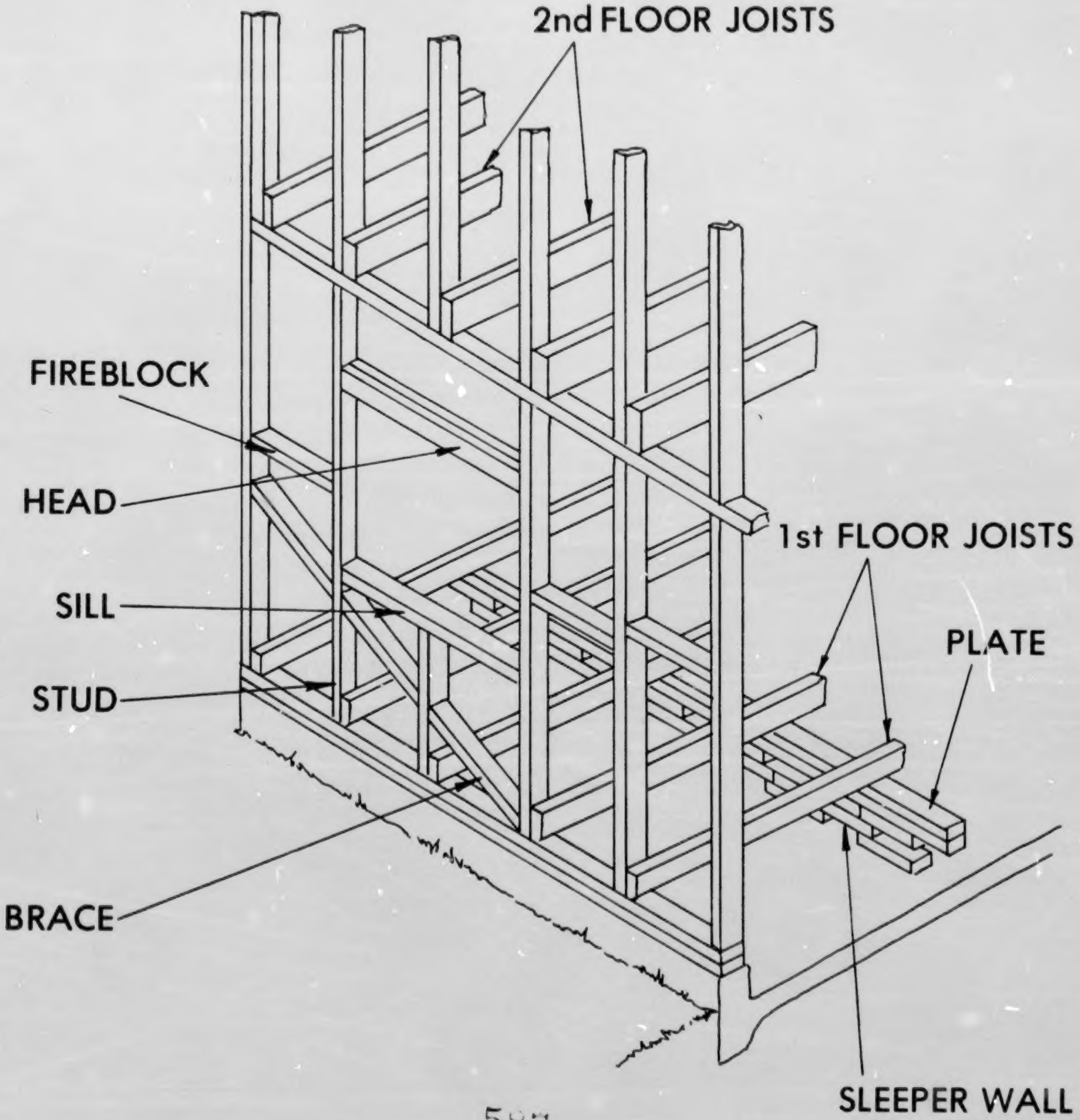
   (NOTE: This works if the fire block is fairly high in the wall.)

2. Top drilling with door trim and baseboard removal (Transparency 5)

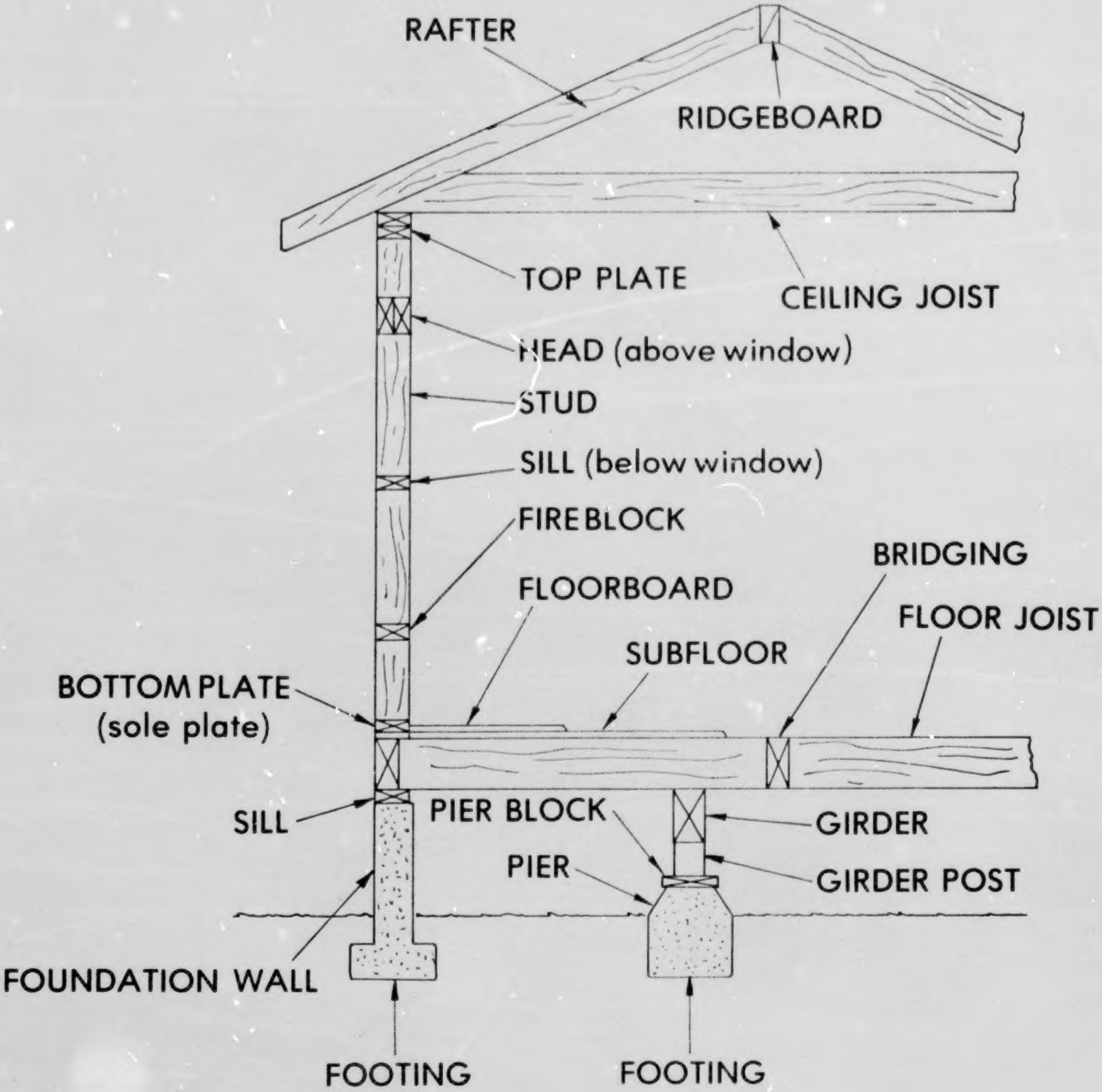
3. Top drilling and channeling past (Transparency 6)

   (NOTE: Be sure and smooth out your work with spacking or joint compound before laying wallpaper back down.)

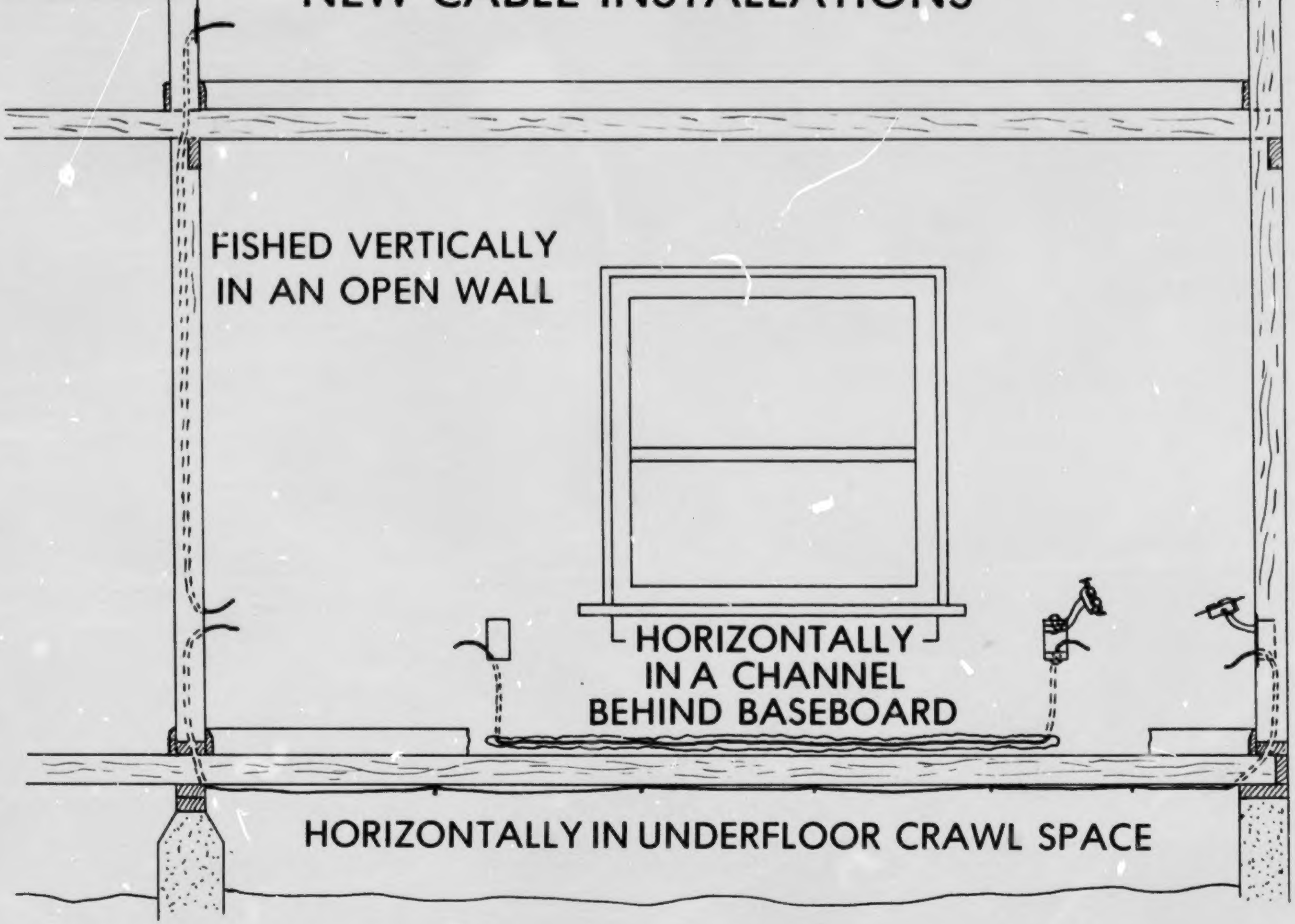
CONSTRUCTION MEMBERS


2nd FLOOR JOISTS
FIREBLOCK
HEAD
1st FLOOR JOISTS
SILL
PLATE
STUD
BRACE
SLEEPER WALL

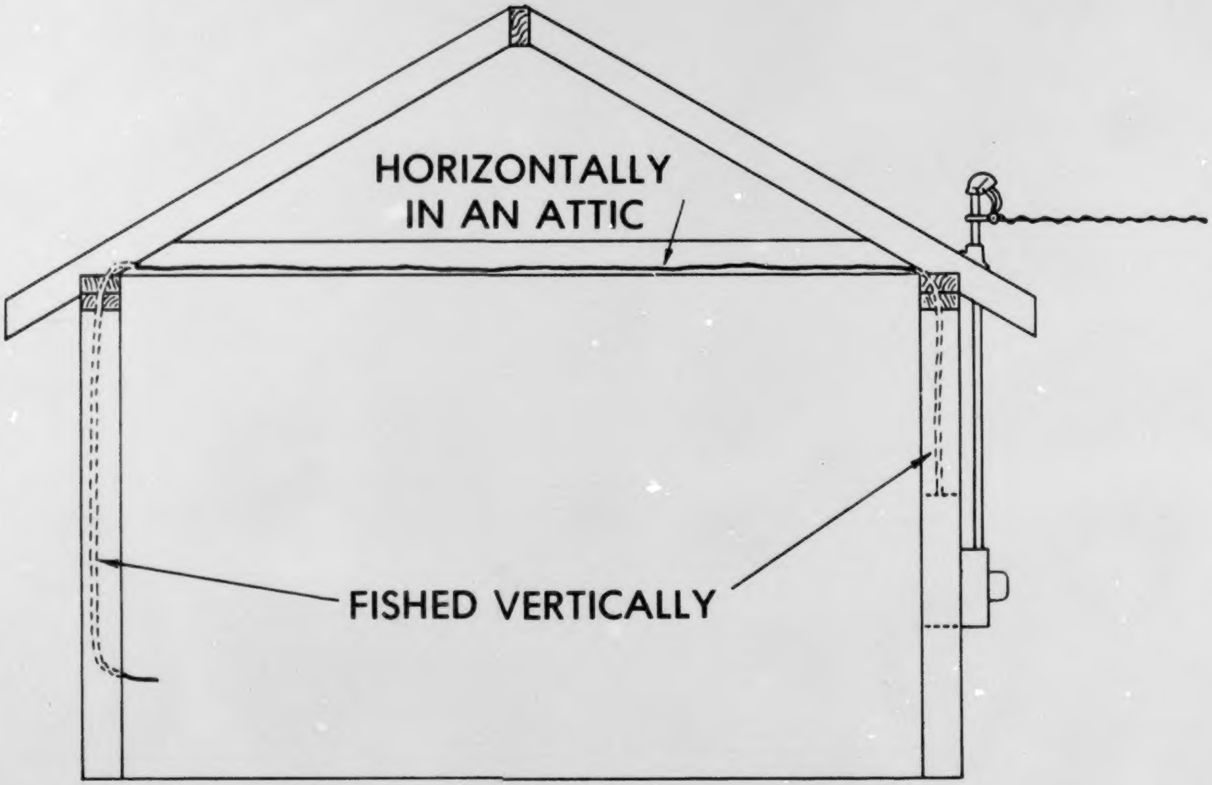
CONSTRUCTION MEMBERS
(continued)


RAFTER
RIDGEBOARD
TOP PLATE
CEILING JOIST
HEAD (above window)
STUD
SILL (below window)
FIREBLOCK
BRIDGING
FLOORBOARD
FLOOR JOIST
SUBFLOOR
BOTTOM PLATE (sole plate)
SILL
PIER BLOCK
GIRDER
PIER
GIRDER POST
FOUNDATION WALL
FOOTING
FOOTING

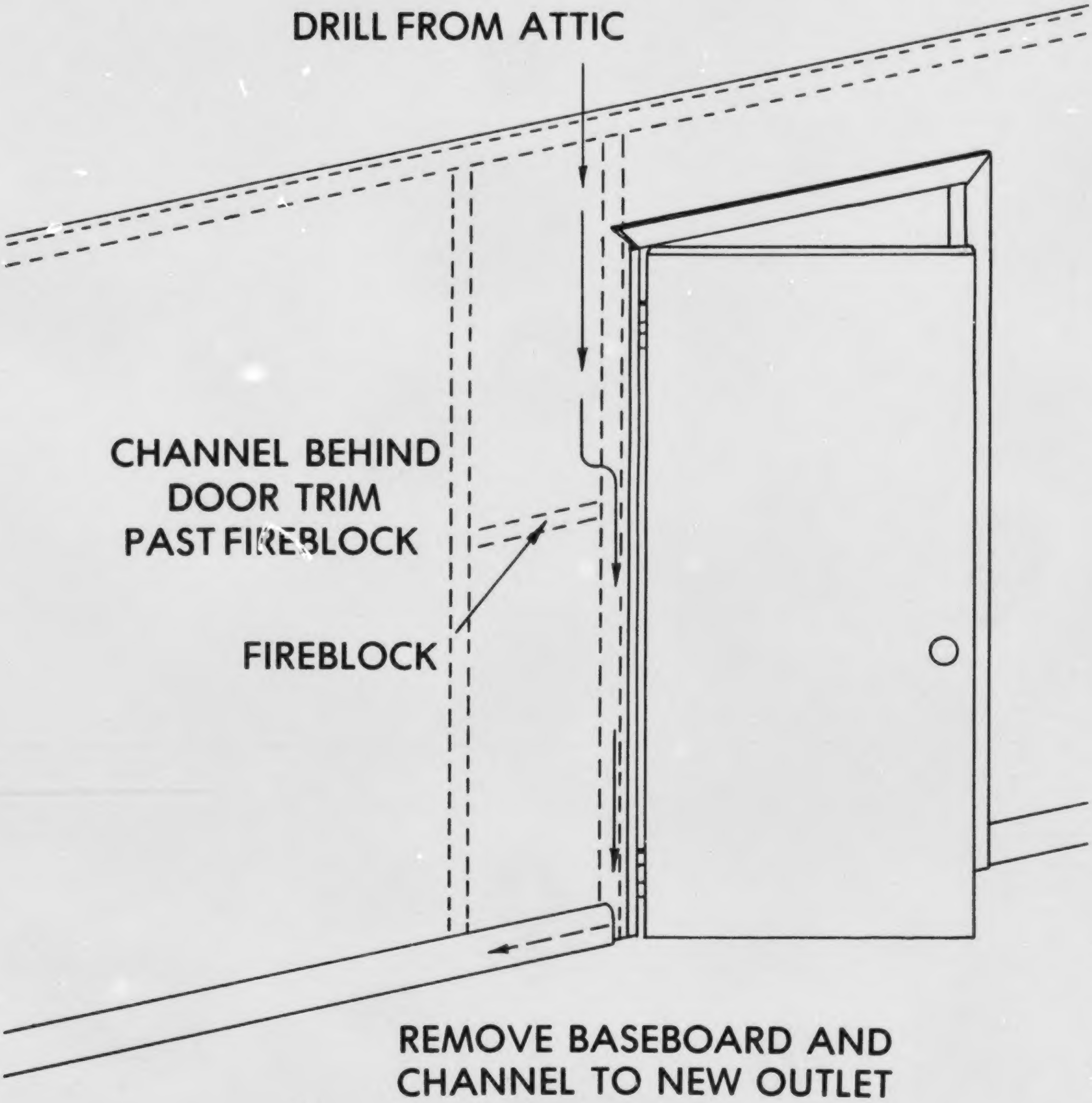
COMMON ROUTES FOR NEW CABLE INSTALLATIONS


FISHED VERTICALLY IN AN OPEN WALL
HORIZONTALLY IN A CHANNEL BEHIND BASEBOARD
HORIZONTALLY IN UNDERFLOOR CRAWL SPACE

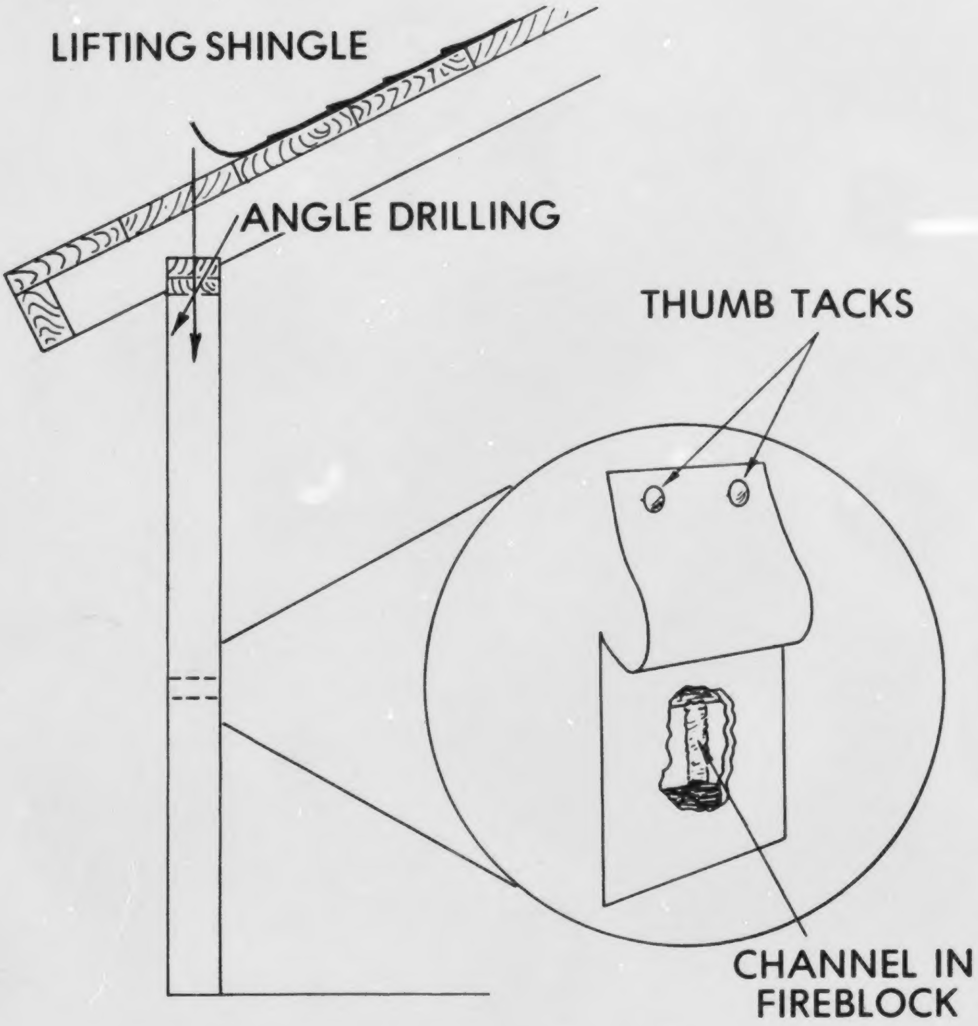
COMMON ROUTES FOR NEW CABLE INSTALLATIONS (continued)


HORIZONTALLY IN AN ATTIC
FISHED VERTICALLY

WORKING PAST FIREBLOCKS


DRILL FROM ATTIC
CHANNEL BEHIND DOOR TRIM PAST FIREBLOCK
FIREBLOCK
REMOVE BASEBOARD AND CHANNEL TO NEW OUTLET

WORKING PAST FIREBLOCKS
(continued)


LIFTING SHINGLE
ANGLE DRILLING
THUMB TACKS
CHANNEL IN FIREBLOCK

CABLE INSTALLATIONS
UNIT I

JOB SHEET #1--INSTALL CABLE BETWEEN AN EXISTING BOX AND A NEWLY INSTALLED BOX HORIZONTALLY ALONG A WALL IN A CHANNEL BEHIND BASEBOARD

I. Tools and equipment

(NOTE: Check with local code enforcing agency on acceptable installation methods before starting.)

A. Pouch tools

B. Keyhole saw

C. 12-2G cable

D. Suitable box with some type of dry wall fasteners

E. Drop cloth

F. Whisk broom

G. Touch up materials

(NOTE: This includes paint and brush if needed.)

H. Safety glasses

I. Chisel

J. Flat bar

II. Procedure

(NOTE: Turn off circuit and check it before starting.)

A. Put on safety glasses

B. Gather tools and equipment

C. Cut in new box

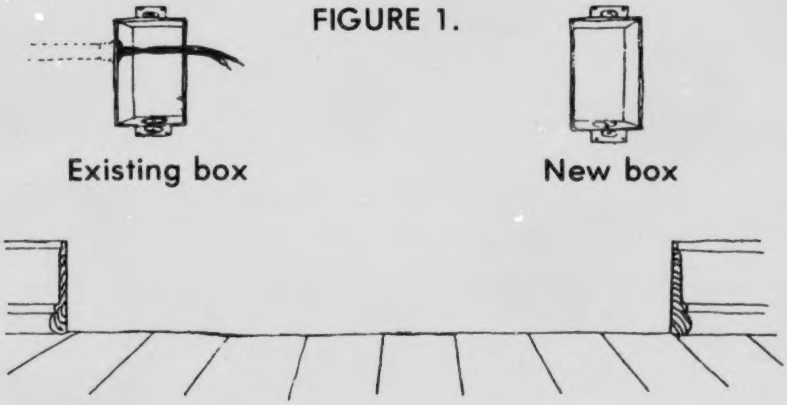
(NOTE: Be sure and consider wall covering material before making your opening.)

JOB SHEET #1

D. Remove baseboard between boxes (Figure 1)

(NOTE: The illustrations will show boxes on the same wall. Baseboard will have to be removed from two walls if you go around the corner for the new box.)

FIGURE 1.



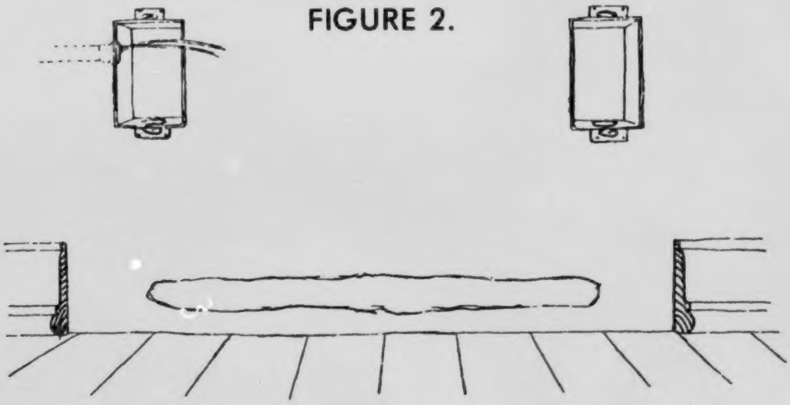
1. Pry baseboard out with flat bar
2. Start at one end and work evenly along baseboard
3. Cut nails flush to baseboard
4. Lay baseboard aside until needed

E. Place drop cloth along floor line

F. Form channel with hammer and chisel (Figure 2)

(NOTE: Be sure your channel is behind the baseboard. Most older houses have a sufficiently tall baseboard.)

FIGURE 2.

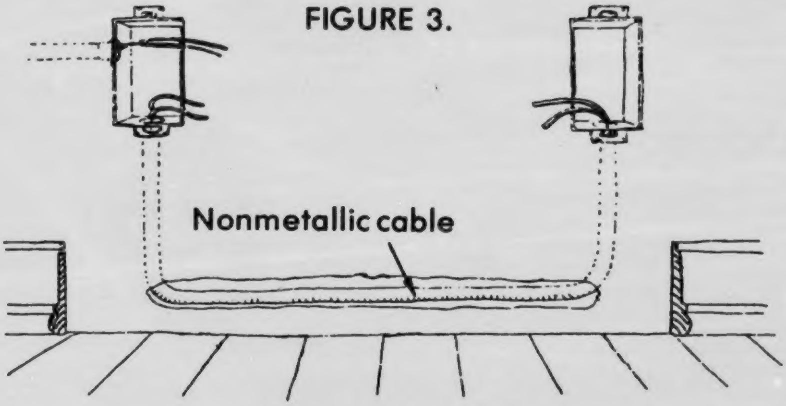


JOB SHEET #1

G. Install cable (Figure 3)

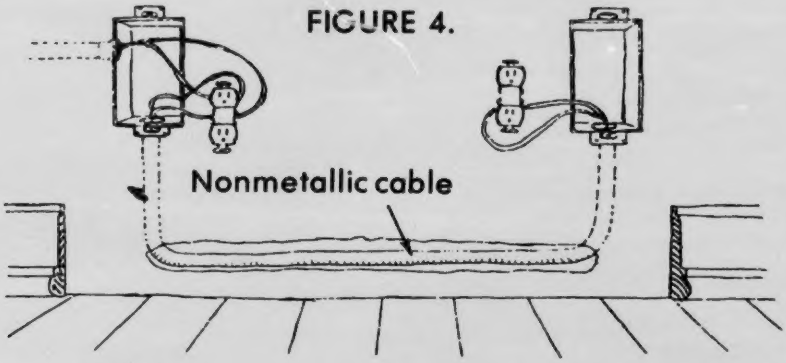
(NOTE: You may have to bore a hole through a piece of lath or through the top edge of a bottom plate.)

FIGURE 3.


Nonmetallic cable

H. Install devices (Figure 4)

FIGURE 4.

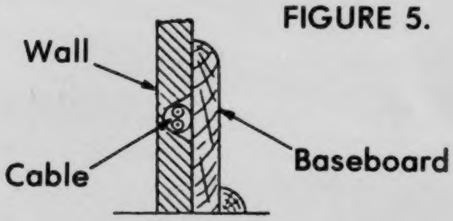

Nonmetallic cable

I. Replace baseboard

1. Check cable fit (Figure 5)

   (NOTE: The baseboard should fit back flat against the wall.)

FIGURE 5.


Wall
Cable
Baseboard

2. Renail baseboard

JOB SHEET #1

J. Touch-up baseboard

(NOTE: The homeowner may have some of the original paint.)

K. Pick up drop cloth

L. Clean up area

CABLE INSTALLATIONS
UNIT I

JOB SHEET #2--INSTALL CABLE BETWEEN AN EXISTING BOX AND A NEWLY INSTALLED BOX USING AN UNDERFLOOR CRAWL SPACE

(NOTE: This procedure requires two people, one above and one in the crawl space.)

I. Tools and equipment

   A. Pouch tools

   B. Drop light and cord

   C. Drill motor

   D. Ship auger bit

   E. Suitable box with dry wall fasteners

   F. 12-2G cable

   G. Staples

   H. Drop cloth

   I. Fish wire

   J. String

   K. Tape

   L. Portable GFI

   M. Volt ohmmeter

   N. Safety glasses

II. Procedure

   (NOTE: Turn off and check circuit before starting. Be sure that there is space under the floor to work before this method is used.)

   A. Put on safety glasses

   B. Gather tools and equipment

   C. Cut in new box

   D. Remove existing device

JOB SHEET #2

E. Locate crawl space access hole

F. Connect GFI to outlet and cord to GFI

G. Locate place to drill

(NOTE: A nail can be driven down through the floor or measurements can be taken from above and transferred to below.)

H. Drill holes (Figures 1 and 2)

(NOTE: In some instances you may have to remove baseboard and drill down on outside walls. It is usually better however to drill from below.)

FIGURE 1
Outside Wall

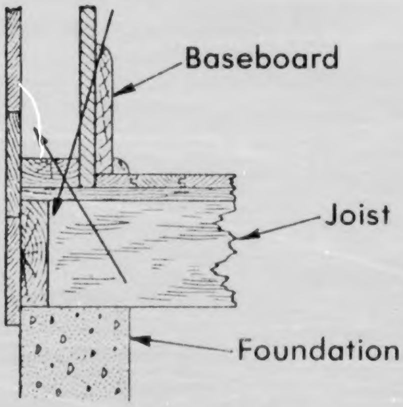
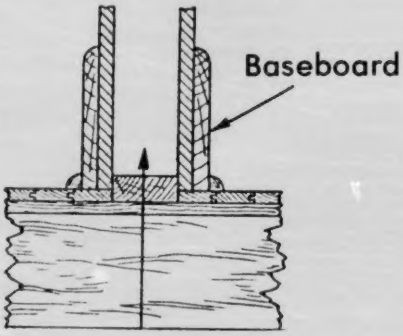


FIGURE 2
Inside wall



I. Make opening at existing box for cable

1. Remove a knockout from box

   (NOTE: If a knockout cannot be removed, remove the box.)

JOB SHEET #2

2. Remove box if necessary

    a. Insert saw between box and stud

    (NOTE: A saw can be constructed with an old or broken hacksaw blade. See Figure 3.)

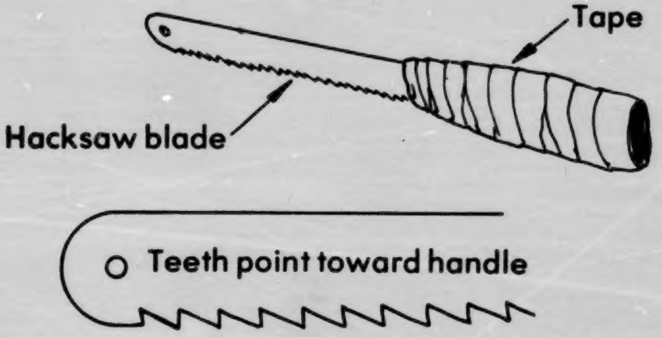

Tape
Hacksaw blade
Teeth point toward handle

FIGURE 3

    b. Cut nails

    c. Move box out of way

J. Fish wire through drilled hole

1. Tape string in loops to cable (Figure 4)

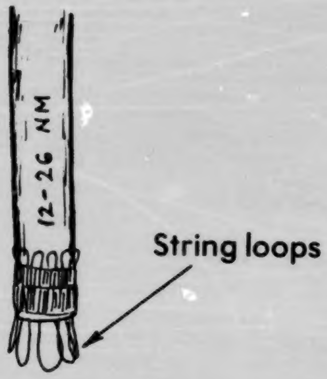

12-26 NM
String loops

FIGURE 4

2. Push cable in opening

JOB SHEET #2

3. Push fish wire with loop up from bottom and wiggle to hook loops (Figure 5)

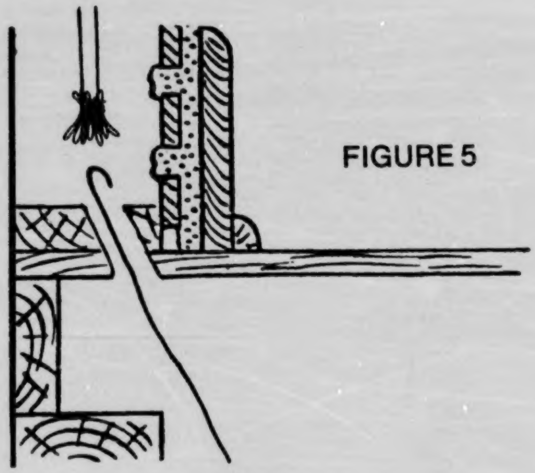


FIGURE 5

4. Pull cable through hole while being fed from above

   (NOTE: This effort needs to be coordinated between the people working. Signals such as two quick jerks for more cable to be fed should be established.)

5. Pull cable over to other hole

6. Push through hole and fish from above

K. Staple cable as code requires

L. Install new box

   (NOTE: Install original existing box if it was removed.)

M. Install devices

N. Activate circuit and test it

O. Clean up area

P. Pick up tools and equipment

Q. Reseal crawl space access hole

CABLE INSTALLATIONS
UNIT I

JOB SHEET #3--INSTALL CABLE BETWEEN AN EXISTING BOX AND A NEWLY INSTALLED BOX USING ATTIC SPACE

(NOTE: This job requires the coordinated effort of two people.)

I. Tools and equipment

   A. Pouch tools

   B. Drop light and cord

   C. Drill motor

   D. Ship auger bit

   E. Suitable box with dry wall fasteners

   F. 12-2G cable

   G. Staples

   H. Drop cloth

   I. Drop chain

   J. Steel fish tape

   K. Volt-ohmmeter

   L. Ladder

   (NOTE: Ladder should be tall enough to allow easy entry into attic.)

   M. Tape

   N. Safety glasses

   O. Dust mask

   P. Portable GFI

II. Procedure

   (NOTE: Be sure and turn off and check circuit before starting.)

   A. Put on safety glasses

   B. Gather tools and equipment

JOB SHEET #3

C. Put down drop cloth

D. Remove existing device

E. Plug in GFI and drop light

F. Set up ladder at access hole

G. Put the following materials up in the attic

  1. Pouch tools
  2. Drop chain
  3. Drop light
  4. Drill motor and bit
  5. Distances measured for drilling written on paper

H. Put on dust mask

I. Enter the attic carefully

(NOTE: When traveling across the attic be sure and walk on ceiling joists. You may have to brush insulation aside as you walk to locate them.)

J. Locate spot to drill

K. Drill hole

(NOTE: On inside walls drilling should be no problem. On outside walls the pitch of the roof may effect how you get through or around the top plate.)

L. Drop one end of chain in the hole

(NOTE: You can stick a screwdriver through one end of the chain to be sure it does not slip from your hand and fall through the hole. Insulated exterior walls may require the use of a solid wire or fish tape.)

M. Shake chain till located below through opening

N. Cut in new box

(NOTE: Measurements should be taken carefully so the holes bored from the attic are in the right stud space.)

O. Pull end of chain through hole

JOB SHEET #3

P. Fasten chain to cable

1. Strip about 6" of outer cable sheath
2. Strip about 2" of insulation from conductors
3. Insert conductors in chain loops and bend over (Figure 1)

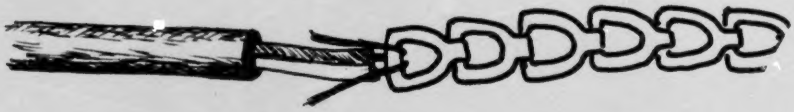


FIGURE 1.

4. Tape the connecting joint back over the cable (Figure 2)

   (NOTE: A smooth joint allows the cable to pass through the drilled hole without hanging up.)

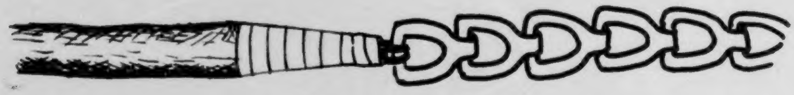


FIGURE 2.

Q. Pull up into attic

(NOTE: A couple of tugs on the chain can signal the attic man to start pulling up. Cable should be pulled in two or three feet lifts to allow feed man to straighten cable as it is fed.)

R. Pull enough cable to go over to next hole and down to existing box

(NOTE: Pull plenty, because you can refeed excess back down to new box before it is cut.)

S. Drill hole above existing outlet

(NOTE: Sometimes a hole already exists where another cable goes down. Use this space if large enough.)

T. Drop chain into hole

U. Fish chain out of existing box

(NOTE: If a knockout will not allow you to fish chain, cut nails and remove box.)

JOB SHEET #3

V. Pull out enough cable for installation

W. Pull excess back through new hole

X. Staple cable in attic

Y. Remove tools and equipment from attic

(NOTE: Ground man should be waiting to receive materials as they are handed down.)

Z. Replace attic access cover

AA. Install devices

BB. Activate circuit

CC. Test devices

DD. Clean up area

CABLE INSTALLATIONS
UNIT I

NAME ____________________

TEST

1. Match the terms on thes right to the correct definitions.

_____a. Groove formed in materials

_____b. Establishing a connection between two points so a cable can be installed

_____c. Cloth or covering used to catch chips or dust

_____d. Length of wire with a hook formed in one end to catch materials being fished in a space

_____e. Working space underneath the house

1. Fish
2. Channel
3. Underfloor crawl space
4. Drop cloth
5. Fish wire

2. Identify the construction members in the two illustrations.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

i. ____________________

j. ____________________

k. ____________________

l. ____________________

m. ____________________

n. ____________________

o. ____________________

p. ____________________

q. ____________________

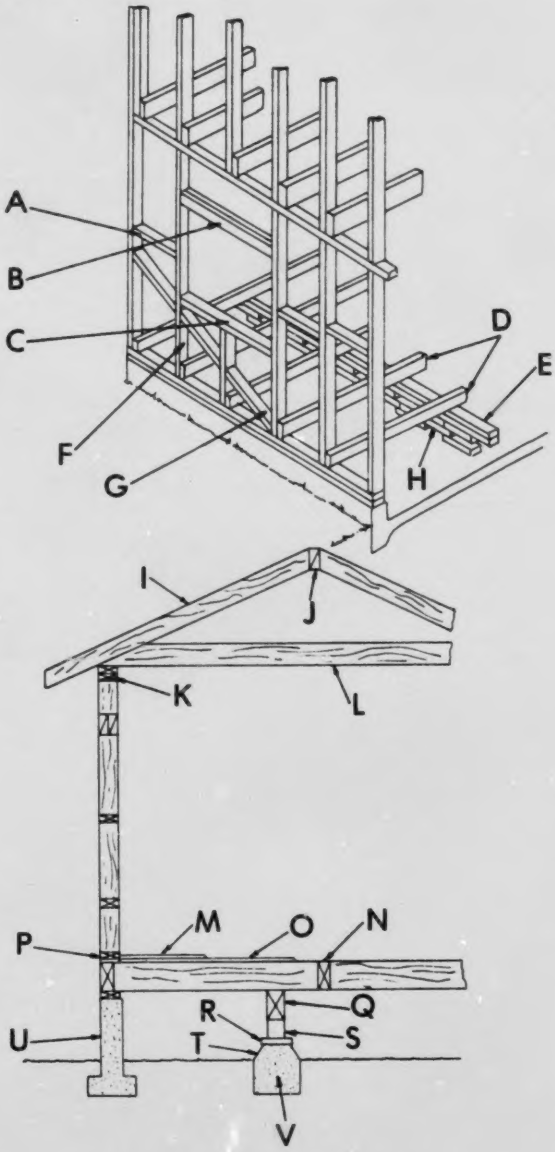
r. ____________________

s. ____________________

t. ____________________

u. ____________________

v. ____________________


A
B
C
D
E
F
G
H
I
J
K
L
M
O
N
P
Q
R
S
T
U
V

3. List four common routes for new cable installations in existing dwellings.

a.

b.

c.

d.

4. List possible methods for getting cable through or around construction members.

   a. Top plates

      1)

      2)

      3)

      4)

   b. Bottom plates (sole plate)

      1)

      2)

   c. Fire blocks

      1)

      2)

      3)

5. Demonstrate the ability to:

   a. Install cable between an existing box and a newly installed box horizontally along a wall in a channel behind baseboard.

   b. Install cable between an existing box and a newly installed box using an underfloor crawl space.

   c. Install cable between an existing box and a newly installed box using attic space.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

CABLE INSTALLATIONS
UNIT I

ANSWERS TO TEST

1. a. 2
   b. 1
   c. 4
   d. 5
   e. 3
2. a. Fireblock
   b. Header
   c. Sill
   d. First floor joists
   e. Plate
   f. Stud
   g. Brace
   h. Sleeper wall
   i. Rafter
   j. Ridge board
   k. Top plate
   l. Ceiling joists
   m. Floor board
   n. Bridging
   o. Sub floor
   p. Bottom plate (sole plate)
   q. Girder
   r. Pier block
   s. Girder post

t. Pier

u. Foundation wall

v. Footing

3. a. Vertically in a wall

   b. Horizontally in a channel behind baseboard

   c. Horizontally in underfloor crawl space

   d. Horizontally in an attic

4. a. 1) Straight drilling

      2) Angle drilling

      3) Lifting a shingle and drilling

      4) Over top plate and back through insulation board inside eave

   b. 1) Top drilling behind baseboard

      2) Bottom drilling

   c. 1) Lifting shingle and top drilling through block with extension

      2) Top drilling with door trim and baseboard removal

      3) Top drilling and channeling past

5. Performance skills evaluated to the satisfaction of the instructor

BOX INSTALLATIONS
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms to the correct definitions, list wall and ceiling compositions that may be found in a residence and install boxes in various types of walls and ceilings. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with box installations to the correct definitions.
2. List five wall or ceiling compositions that may be found in a residential dwelling.
3. Demonstrate the ability to:
    a. Install a box with dry wall grips in a plasterboard wall.
    b. Secure a box with dry wall supports (boxtins).
    c. Install a box in a lath and plaster wall.
    d. Install a box in a paneled wall.
    e. Install a box in a concrete block wall.
    f. Install a box in a brick wall.
    g. Install a box in a ceiling with an accessible attic.

BOX INSTALLATIONS
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Discuss unit and specific objectives.

  D. Discuss information and job sheets.

  E. Demonstrate and discuss the procedures outlined in the job sheets.

  F. Discuss possible problems that can arise in cutting in boxes in existing walls.

  G. Demonstrate knife scoring technique for cutting box opening in plasterboard.

  H. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Job sheets

    1. Job Sheet #1--Install a Box with Dry Wall Grips in a Plasterboard Wall

    2. Job Sheet #2--Secure a Box with Dry Wall Supports (Boxtins)

    3. Job Sheet #3--Install a Box in a Lath and Plaster Wall

    4. Job Sheet #4--Install a Box in a Paneled Wall

    5. Job Sheet #5--Install a Box in a Concrete Block Wall

    6. Job Sheet #6--Install a Box in a Brick Wall

    7. Job Sheet #7--Install a Box in a Ceiling with an Accessible Attic

E. Test

F. Answers to test

II. References:

A. Herrick, Clyde. *Residential Electrical Wiring.* Santa Monica, California: Goodyear Publishing Company, Inc., 1976.

B. *National Electrical Code, 1978.* Boston, Massachusetts: National Fire Protection Association, 1977.

BOX INSTALLATIONS
UNIT II

INFORMATION SHEET

I. Terms and definitions

   A. Plasterboard (sheetrock)--Flat sheets used in construction as a wall covering; it has an outer covering of felt sandwiching a gypsum plaster core

   B. Lath and plaster--Old method for covering interior walls; small strips of wood spaced evenly over studs to support and hold plaster

   C. Drop cloth--Cloth used to catch falling debris from cutting or chipping work

   D. Stud finder--Compass type tool which uses a magnet to locate nails and thus indicate stud locations

   E. Brick bat--Piece of a brick

II. Wall or ceiling composition

   A. Plasterboard

   (NOTE: This is commonly called sheetrock and is used in the majority of the interior walls in new residences.)

   B. Lath and plaster

   C. Paneling

   D. Concrete block

   E. Brick

BOX INSTALLATIONS
UNIT II

JOB SHEET #1--INSTALL A BOX WITH DRY WALL GRIPS IN A PLASTERBOARD WALL

I. Tools and equipment

A. Plasterboard wall

B. Box with plaster ears and dry wall grips

(NOTE: Several forms of attaching devices are made for securing boxes to dry wall plasterboard.)

C. Pouch tools

D. 1/2" drill bit

E. Brace or drill motor and cord

F. Pencil

G. Keyhole saw

H. Safety glasses

I. Drop cloth

II. Procedure

(NOTE: Be sure that you are going to be able to get a cable to where the box is to be cut in before starting.)

A. Gather tools and equipment and put on safety glasses

B. Mark box height on wall

C. Pencil around the box (Figure 1)

(NOTE: Tap along the wall listening for hollow spaces or use a stud finder to make sure that a stud will not be in the cut out for the box.)

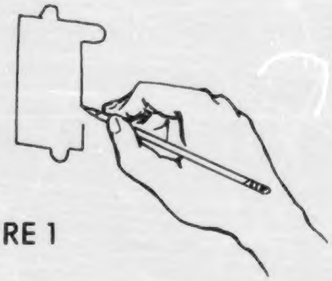


FIGURE 1

JOB SHEET #1

D. Place drop cloth below work area

E. Drill holes in two of the corners (Figure 2)

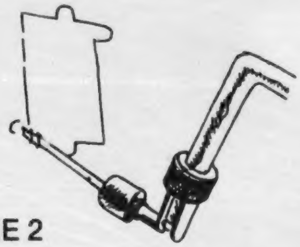


FIGURE 2

F. Saw along drawn lines (Figure 3)

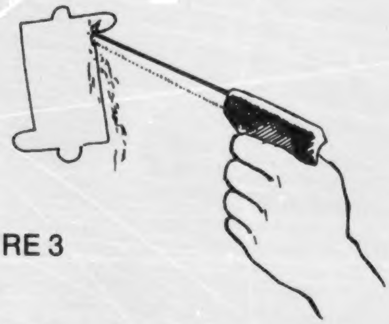


FIGURE 3

G. Fit box into opening (Figure 4)

(NOTE: You may need to do some trimming. The plasterboard will chalk white places on the box in areas where trimming is needed.)

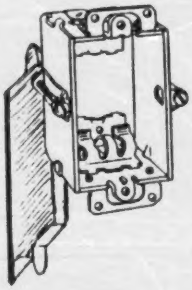


FIGURE 4

H. Remove box

I. Insert conductors

JOB SHEET #1

J. Replace box in opening (Figure 5)

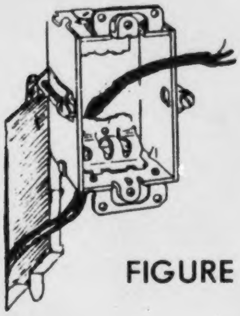


FIGURE 5

K. Secure box

(NOTE: Tighten screw until box is secure.)

L. Pick up drop cloth

M. Clean up area

BOX INSTALLATIONS
UNIT II

JOB SHEET #2--SECURE A BOX WITH DRY WALL SUPPORTS (BOXTINS)

I. Tools and materials

(NOTE: This job sheet deals only with the securing of boxes after the cable has been run and the opening cut.)

- A. Dry wall box with ears
- B. Drywall hangers
- C. Opening in dry wall
- D. Lineman's pliers

II. Procedure

- A. Place box in opening
- B. Grip hanger in one hand (Figure 1)

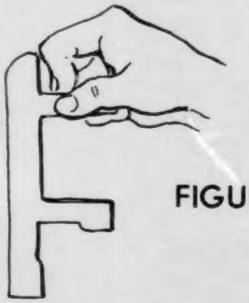


FIGURE 1

- C. Insert bottom of hanger beside box (Figure 2)

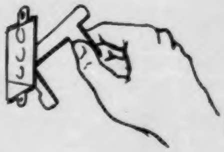


FIGURE 2

- D. Push top of hanger in (Figure 3)

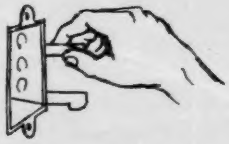


FIGURE 3

JOB SHEET #2

E. Raise hanger about 1/2" (Figure 4)

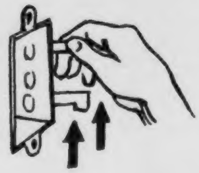


FIGURE 4

F. Apply outward pressure on hanger (Figure 5)

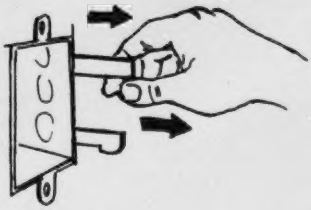


FIGURE 5

G. Put inward pressure on box with other hand (Figure 6)

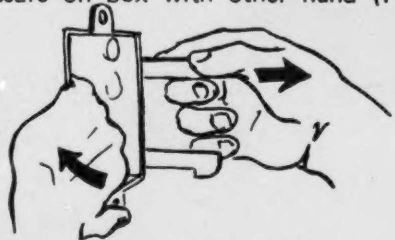


FIGURE 6

H. Bend tang over to secure box (Figure 7)

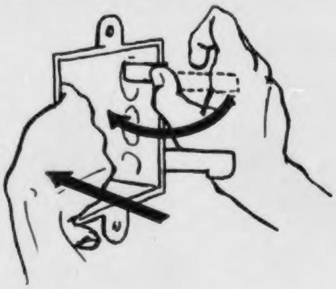


FIGURE 7

I. Bend other tang (Figure 8)

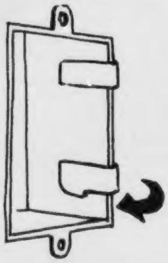


FIGURE 8

JOB SHEET #2

J. Grasp other hanger (Figure 9)

(NOTE: It should be inserted with the long spine in the opposite direction of the first.)

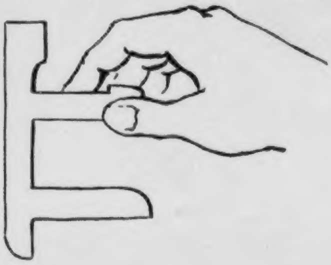


FIGURE 9

K. Secure in wall using steps "C" through "I"

L. Pinch tangs with lineman's pliers (Figure 10)

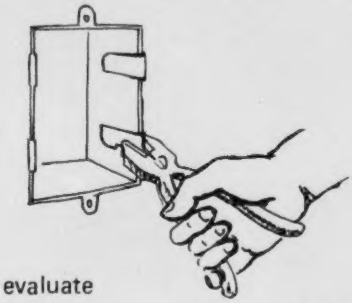


FIGURE 10

M. Have instructor evaluate

N. Clean up area

BOX INSTALLATIONS
UNIT II

JOB SHEET #3--INSTALL A BOX IN A LATH AND PLASTER WALL

I. Tools and equipment

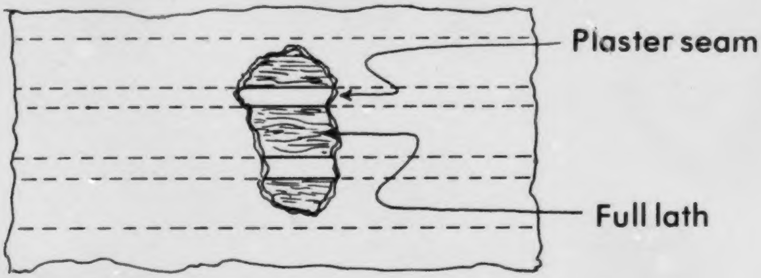
- A. Lath and plaster wall
- B. Box with plaster ears
- C. Two #6 or #4 x 3/4" metal tapping or wood screws
- D. Pouch tools
- E. Keyhole saw
- F. Pencil
- G. Safety glasses
- H. Drop cloth

II. Procedure

(NOTE: Be sure that you are going to be able to get a cable to where the box is to be cut in before starting.)

- A. Gather tools and equipment and put on safety glasses
- B. Mark box height on wall
- C. Place drop cloth below work area
- D. Punch a hole near your mark with a screwdriver
- E. Locate full lath (Figure 1)

FIGURE 1



JOB SHEET #3

F. Pencil around box using full lath as center point (Figure 2)

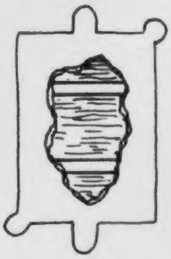


FIGURE 2

G. Break out plaster along penciled line with screwdriver (Figure 3)

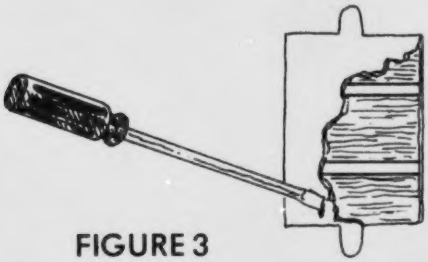
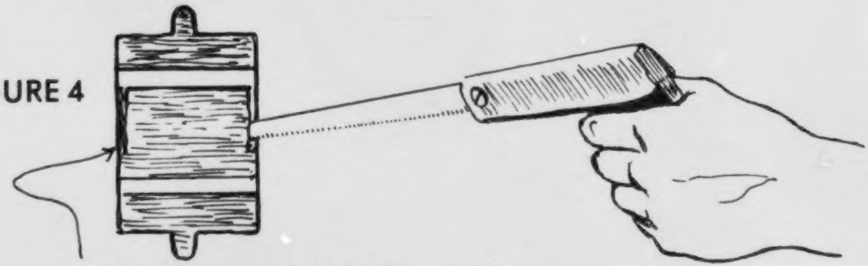


FIGURE 3

H. Cut center lath completely out (Figure 4)

FIGURE 4



(didn't cut completely through)

(NOTE: It will be easier if you don't cut completely through one side before starting on the other. Leaving a small connecting point stops a lot of vibration. Sometimes it may be necessary to wedge the lath with a screwdriver to eliminate vibration.)

I. Cut enough of top and bottom lath to accommodate box

JOB SHEET #3

J. Install cable in box

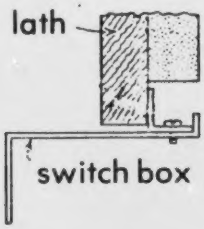
K. Place box in opening

L. Secure with screws

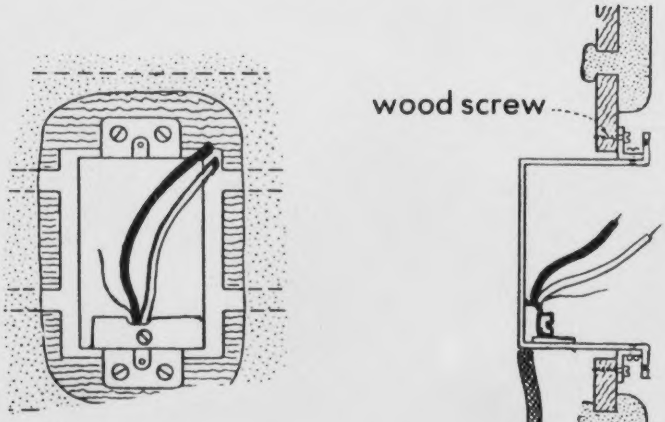
M. Reset plaster ears if plaster breaks from behind ears

(NOTE: If the plaster is not solid enough to provide firm support, clean it out from behind ears. See Figure 5.)

FIGURE 5



N. Secure with screws (Figure 6)



front view

FIGURE 6

side view

O. Pick up drop cloth

P. Clean up area

BOX INSTALLATIONS
UNIT II

JOB SHEET #4--INSTALL A BOX IN A PANELED WALL

I. Tools and equipment

  A. Paneled wall

  B. Pouch tools

  C. 1/2" drill bit

  D. Brace or drill motor and cord

  E. Keyhole saw

  F. Pencil

  G. Drop cloth

  H. Switch box with ears

  I. Four #6 x 3/4 metal tapping or woodscrews

  (NOTE: If plasterboard is behind the paneling you can use one of the forms of dry wall grips.)

  J. Masking tape

  K. Safety glasses

  L. Portable GFI

II. Procedure

(NOTE: Be sure that you are going to be able to get a cable to where the box is to be cut in before starting.)

  A. Gather tools and material

  B. Mark box height on wall

  C. Pencil around box

  (NOTE: Notice nail locations or use a stud finder or tap for hollow sounds to make sure you are in a hollow space.)

  D. Put masking tape over lines and re-mark if not visible

  (NOTE: This will keep wood from splintering while drilling and sawing.)

  E. Place drop cloth below work area

JOB SHEET #4

F. Cut along penciled lines with knife (Figure 1)

(NOTE: If you don't cut through the top layer of the paneling it will splinter out when you start sawing.)

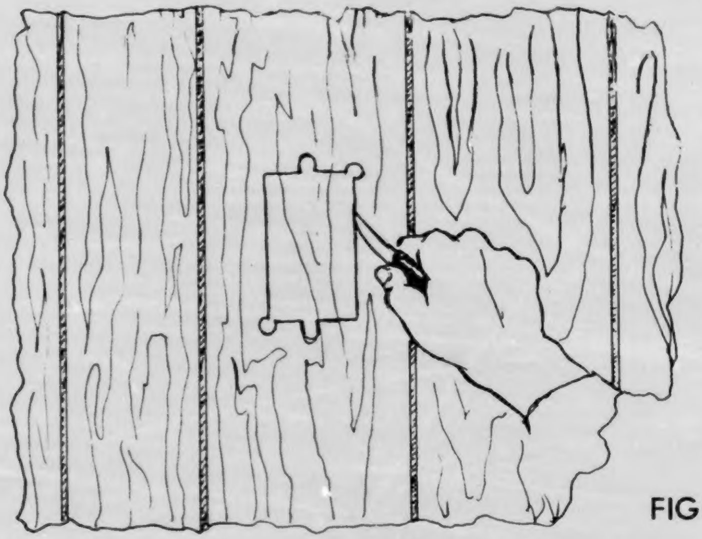


FIGURE 1

G. Drill holes in two corners of penciled in box

(NOTE: Be sure and plug cord into GFI if a drill motor is used.)

H. Saw out opening

(NOTE: Saw inside of your knife cut to avoid splintering of the paneling.)

I. Fit box into opening

(NOTE: If you have to trim the opening use your knife instead of the saw to avoid splintering.)

J. Remove box

K. Install cable

L. Reinstall box in opening

M. Secure box

N. Remove masking tape

O. Pick up drop cloth

P. Clean up area

BOX INSTALLATIONS
UNIT II

JOB SHEET #5--INSTALL A BOX IN A CONCRETE BLOCK WALL

I. Tools and equipment

A. Pouch tools

B. Concrete block wall

C. Concrete chisel

D. Switch box with ears

E. Pencil

F. Mortar

(NOTE: This can be a commercial pre-mix or sand and cement mixture you blend yourself.)

G. Wood scraps

II. Procedure

(NOTE: Be sure you will be able to get a cable to where the box will be cut in before starting.)

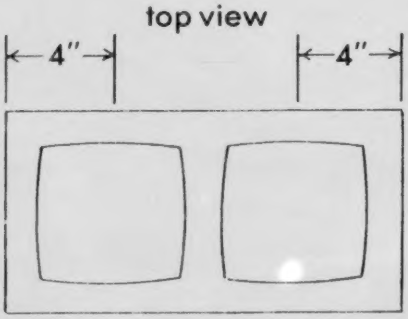
A. Gather tools and equipment and put on safety glasses

B. Mark approximate box height

(NOTE: Make your mark in a mortar joint at the top or bottom edge of a block.)

C. Pencil around box

(NOTE: Make sure your box will be centered in a hollow space in the block. Four inches from either end should be a hollow space on an 8" x 8" x 16" block.)



JOB SHEET #5

D. Tap chisel along pencil lines with hammer (Figure 1)

(NOTE: This should be done until a groove approximately one sixteenth of an inch deep replaces your penciled outline.)

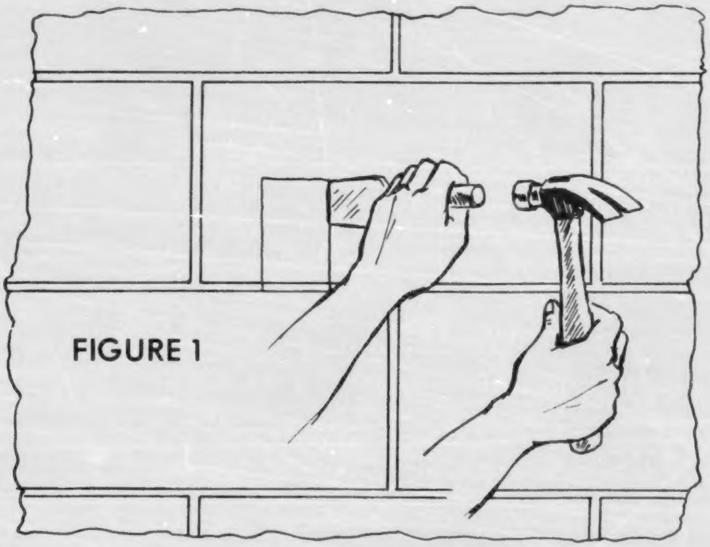


FIGURE 1

E. Knock mortar out along box outline (Figure 2)

(NOTE: If mortar is difficult to remove you can drill it out. Be sure and use portable GFI.)

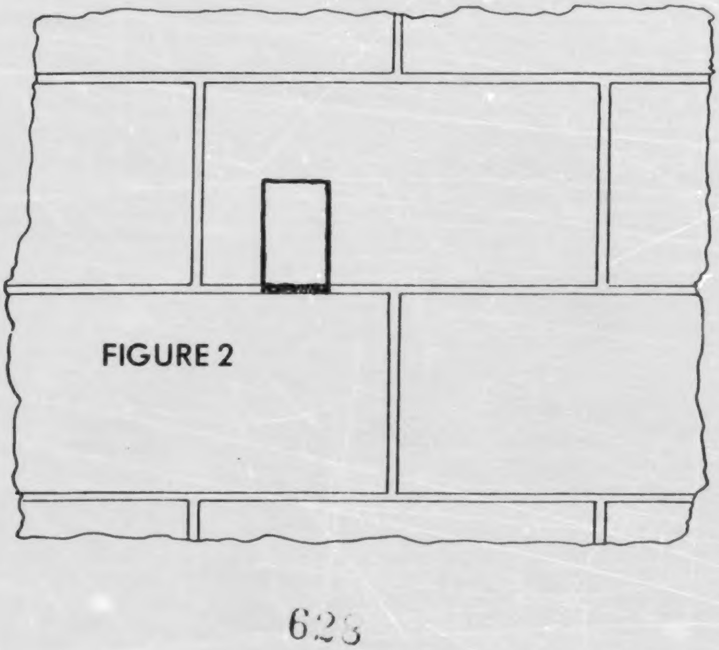


FIGURE 2

JOB SHEET #5

F. Tap center of box outline with hammer (Figure 3)

(NOTE: After several taps a hole will form.)

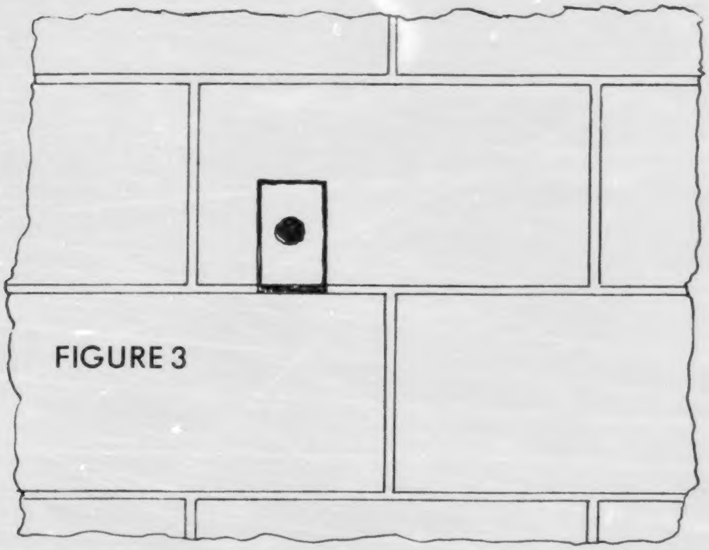


FIGURE 3

G. Gently tap from center hole towards the grooved box outline

(NOTE: The block should crack off at the groove. Don't get in a hurry. Slowly work around the groove until the opening is formed.)

H. Fit box into opening

(NOTE: The hole may have to be dressed with the chisel until the box fits.)

I. Remove box

J. Install cable in box

(NOTE: You may have to enter the back of the box; in this event you'll need a 3/8" cable clamp.)

K. Reinstall box in opening

JOB SHEET #5

L. Secure box with narrow wood wedges (Figure 4)

(NOTE: The wedges can be made by chipping at the end of a two by four with your hammer claws. Put one wedge at the top and one at the bottom in opposite corners.)

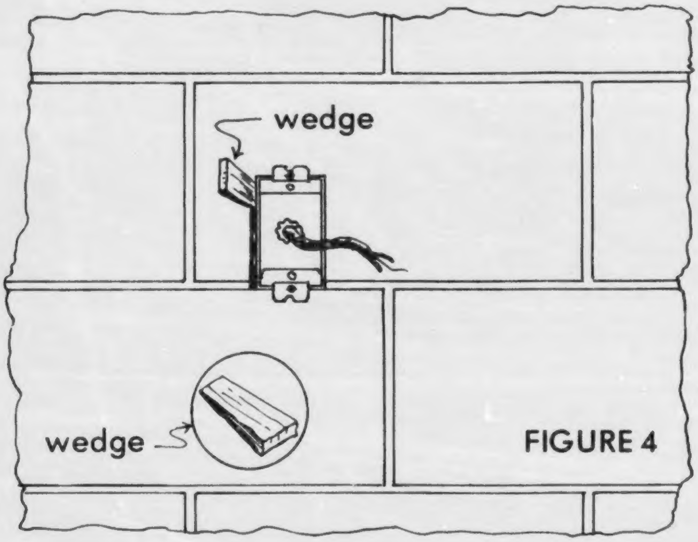


FIGURE 4

M. Flush off wood securing wedges

(NOTE: Even if box seems secure you must use mortar or construction adhesive to finish the process.)

N. Mix up small amount of mortar

O. Force mortar between box and opening in block

P. Smooth out excess mortar

Q. Clean up area

BOX INSTALLATIONS
UNIT II

JOB SHEET #6--INSTALL A BOX IN A BRICK WALL

I. Tools and equipment

   A. Brick wall

   B. Pouch tools

   C. 1/4" masonry bit

   (NOTE: The bit could be larger; however a larger bit will usually take more time to make the necessary penetrations.)

   D. Drill motor and cord

   E. Switch box with ears

   F. 2 plastic anchors with appropriate bit and screws

   G. Concrete chisel

   H. Pencil

   I. Mortar

   J. 3/8" cable clamp

   K. Portable GFI

   L. Safety glasses

II. Procedure

   (NOTE: Be sure you are going to be able to get a cable to where the box is to be cut in before starting.)

   A. Gather tools and equipment and put on safety glasses

   B. Mark box height on wall

JOB SHEET #6

C. Pencil around the box (Figure 1)

(NOTE: Place the box horizontally so that only one cut is needed in a brick. If existing outlets are installed vertically then this box should also be installed vertically.)

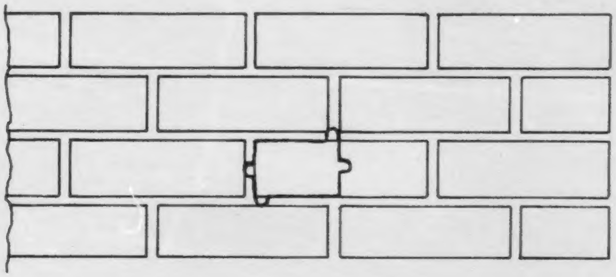


FIGURE 1

D. Chisel the mortar from around your penciled in box (Figure 2)

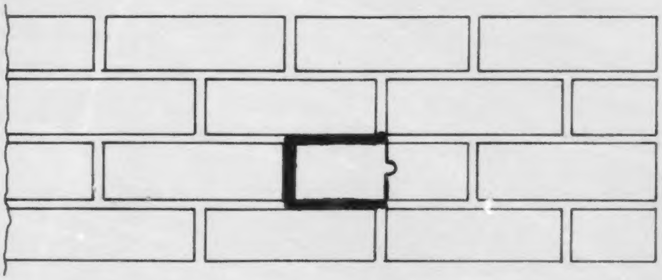


FIGURE 2

E. Drill three or four holes along box outline in brick (Figure 3)

(NOTE: Be sure and use GFI with your power tools.)

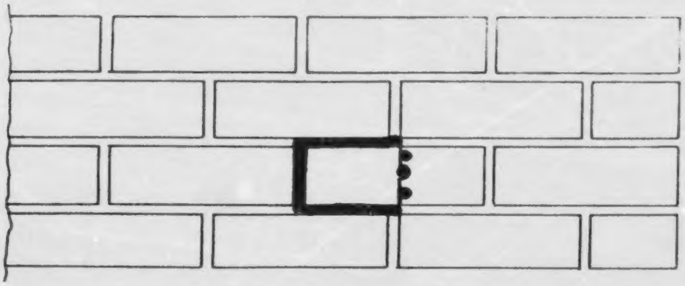


FIGURE 3

F. Chisel a groove between the drill holes

(NOTE: The brick may break while you are grooving it.)

JOB SHEET #6

G. Tap on the free end of the brick until it breaks

(NOTE: Do not push the brick bat back into the wall. Remove it from the wall when it breaks.)

H. Fit box in opening

(NOTE: You may have to dress the hole up with the concrete chisel.)

I. Mark holes in plaster ears for anchors (Figure 4)

(NOTE: One in each ear will be sufficient.)

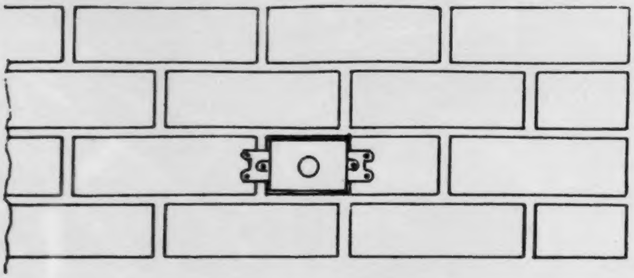


FIGURE 4

J. Remove box

K. Install anchors

1. Measure anchor on drill bit (Figure 5)

   (NOTE: This tells you when to stop so your anchor will bottom out.)

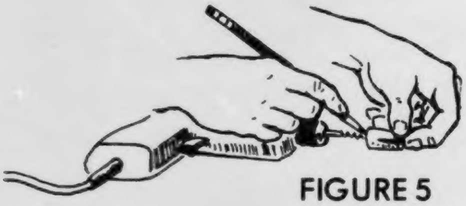


FIGURE 5

2. Drill hole to marked depth (Figure 6)

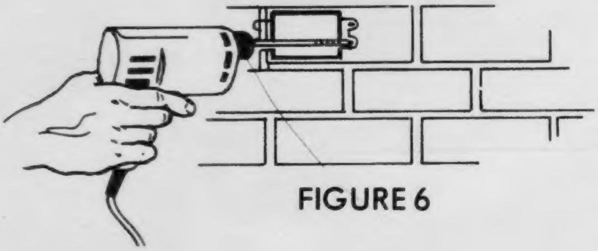


FIGURE 6

JOB SHEET #6

3. Insert small end of anchor in hole (Figure 7)

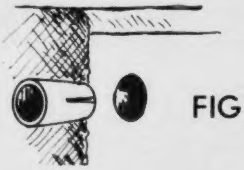


FIGURE 7

4. Tap with screwdriver butt to seat (Figure 8)

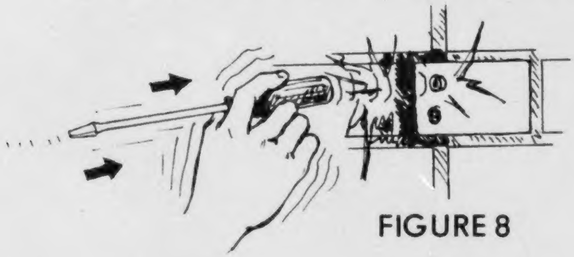


FIGURE 8

L. Replace cable in box

M. Secure cable clamp

N. Insert box in opening

O. Install screws in anchor

P. Secure box

Q. Mix mortar

R. Fill joints around box

S. Smooth joints with finger

T. Clean up area

BOX INSTALLATIONS
UNIT II

JOB SHEET #7--INSTALL A BOX IN A CEILING WITH AN ACCESSIBLE ATTIC

I. Tools and equipment

A. Pouch tools

B. Keyhole saw

C. Octagon box

D. Bar hanger

E. Pencil

F. Drop cloth

G. Step ladder

(NOTE: Remember to be safety conscious when working at all times, and remember the rules for ladder use.)

H. Safety glasses

I. 1/2" drill bit

J. Brace or drill motor and cord

K. 2 single or plasterboard nails

L. Trouble light and bulb

M. Portable GFI

II. Procedure

(NOTE: Be sure you can get a cable to where you are going to cut the box in.)

A. Gather tools and equipment and put on safety glasses

B. Set up ladder

C. Place drop cloth under work area

D. Mark box location on ceiling

E. Pencil around the box

(NOTE: Be sure there is not a ceiling joist above where you plan on cutting the box in.)

JOB SHEET #7

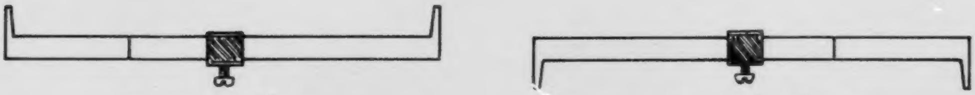
F. Drill a hole in the corner of box outline

G. Saw out the box opening

(NOTE: If the ceiling is lath, chip the plaster off inside your outline before you saw the lath.)

H. Attach bar to box (Figure 1)

(NOTE: Reverse the bar so the nail slots are upward for easy nailing.)



Reversed bar

Standard

FIGURE 1

I. Move ladder to attic access hole

J. Plug in drop light

K. Go into attic with pouch tools, nails, box, and trouble light

L. Walk on ceiling joists over to box opening

M. Position box in hole

N. Nail box between joists (Figure 2)

(NOTE: Be sure box is flush with ceiling.)

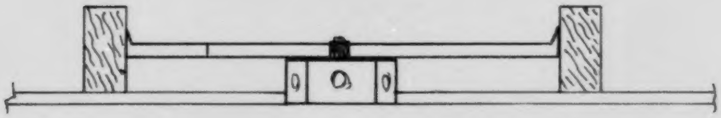


FIGURE 2

JOB SHEET #7

O. Insert cable in box

P. Gather tools and light

Q. Get down from attic

R. Reposition ladder

S. Tighten cable clamp and box support screw

T. Pick up drop cloth

U. Clean up area

BOX INSTALLATIONS
UNIT II

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Old method for covering interior walls; small strips of wood spaced evenly over studs to support and hold plaster

_____b. Flat sheets used in construction as a wall covering; it has an outer covering of felt sandwiching a gypsum plaster core

_____c. Cloth used to catch falling debris from cutting or chipping work

_____d. Compass type tool which uses a magnet to find nails and thus indicate stud locations

_____e. Piece of a brick

1. Plasterboard (sheetrock)
2. Lath and plaster
3. Drop cloth
4. Stud finder
5. Brick bat

2. List five wall or ceiling compositions that may be found in a residential dwelling.

a.

b.

c.

d.

e.

3. Demonstrate the ability to:

a. Install a box with dry wall grips in a plasterboard wall.

b. Secure a box with dry wall supports (boxtins).

c. Install a box in a lath and plaster wall.

d. Install a box in a paneled wall.

e. Install a box in a concrete block wall.

f. Install a box in a brick wall.

g. Install a box in a ceiling with an accessible attic.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

BOX INSTALLATIONS
UNIT II

ANSWERS TO TEST

1. a. 2
   b. 1
   c. 3
   d. 4
   e. 5
2. a. Plasterboard
   b. Lath and plaster
   c. Paneling
   d. Concrete block
   e. Brick
3. Performance skills evaluated to the satisfaction of the instructor

LOAD CENTER CHANGES
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to install and change out load centers in existing residential dwellings. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with load centers to the correct definitions.
2. List four possible ways to increase service size on an existing dwelling.
3. List five procedures for changing an existing residential service.
4. Demonstrate the ability to:
    a. Replace an existing interior flush mount load center.
    b. Install a rainproof load center to supplement an existing interior load center.
    c. Install a fusible safety switch for an air-conditioning condenser.

LOAD CENTER CHANGES
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Discuss unit and specific objectives.

  D. Discuss information sheet.

  E. Demonstrate and discuss the procedures outlined in the job sheets.

  F. Have students bring in information on their service (size, number of circuits, location etc.) and have them describe what would be needed to change it out.

  G. Discuss various types of service change outs.

  H. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete assignment and job sheets.

  D. Bring information on your home service and describe what would be needed to change it out.

  E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

C. Job sheets

1. Job Sheet #1--Replace an Existing Interior Flush Mount Load Center
2. Job Sheet #2--Install a Rainproof Load Center to Supplement an Existing Interior Load Center
3. Job Sheet #3--Install a Fusible Safety Switch for an Air-Conditioning Condenser

D. Test

E. Answers to test

II. Reference--*National Electrical Code* 1981. Boston: National Fire Protection Association, 1980.

LOAD CENTER CHANGES
UNIT III

INFORMATION SHEET

I. Terms and definitions

  A. Air-conditioning condenser--Refrigeration equipment that sits outside a residential dwelling and is used to remove heat from refrigerant; usually contains a hermetically sealed compressor

  B. Full load amps (F.L.A.)--Amperage at which system is designed to operate

  (NOTE: This information can usually be found on the equipment nameplate.)

  C. Life sustaining medical equipment--Equipment necessary to keep patients alive

  (NOTE: This could be an iron lung, kidney machine or any other machine used to replace or sustain a bodily function.)

  D. Outage--Period during which no current is available to circuits in a residential dwelling

II. Possible ways to increase service size

  A. Install larger service entrance conductors in existing raceway and increase load center main breaker

  (NOTE: This will work if raceway is large enough, load center bus is rated for increased size, and main breaker is interchangeable or bus is split.)

  B. Install complete new service entrance conductors, raceway and weather head, and change load center interior

  (NOTE: Some load center manufacturers use a common housing for two or three circuit capacities.)

  C. Make a complete service change out

  (NOTE: This is the most extensive and includes all new equipment.)

  D. Increase service entrance conductor size and set a new exterior load center to feed existing panel as a sub

  (NOTE: Raceway must be changed if it is not rated for increased conductor size.)

INFORMATION SHEET

III. Procedures for changing an existing service

(NOTE: Always check with the local utility company before starting.)

A. Calculate service size needed

(NOTE: It is possible to use Examples 1 1a, 1b, or 1c, from chapter 9 of the NEC in these calculations.)

B. Estimate materials and labor needed

(NOTE: This involves the calculation and availability of all materials and labor.)

C. Consult with customer about best possible time to do the work

(NOTE: Be sure that no life sustaining medical equipment is involved in the outage.)

D. Contact utility company about the project

(NOTE: The utility company will usually want to reconnect the service conductors to the service entrance conductors. They may even need to increase the service conductor size.)

E. Start and complete project

(NOTE: Be sure and be prepared to finish this project once you start unless the dwelling is unoccupied.)

LOAD CENTER CHANGES
UNIT III

JOB SHEET #1--REPLACE AN EXISTING INTERIOR FLUSH MOUNT LOAD CENTER

(NOTE: This job sheet is intended to provide instruction on removing an inadequate or defective load center and replacing it with an appropriate new one. Riser, meter base, and other service equipment will not be dealt with due to the number of variables involved.)

I. Tools and equipment

   A. Pouch tools

   B. Keyhole saw

   C. Hacksaw blade or nail saw

   D. Load center with flush cover

      (NOTE: If you are increasing the size of the load center use Example No. 1, 1(a), 1(b), or 1(c)., from the tables and examples in the back of the NEC to compute the size needed.)

   E. Drop cloth

   F. Knockout cutter set

      (NOTE: If the load center you are changing is fed through a nipple from the meter base and it can be aligned with existing KO's in the new load center you will not need this equipment.)

   G. Safety glasses

   H. Voltmeter

   I. Metal tapping screws or pan head wood screws

      (NOTE: The length of these screws will be determined by the distance between the panel and the stud. Shims may be needed.)

   J. Portable GFI

JOB SHEET #1

II. Procedure

(NOTE: This project must be completed once started. Check with the customer to find when it would be of least inconvenience to have the electricity off for this operation. Be sure there is not any life sustaining medical equipment involved in this outage. Have emergency lighting available.)

A. Gather tools and equipment

(NOTE: Check mentally to be sure you have every possible item needed to finish the job once you start. Contact utility company. They may want to remove the meter.)

B. Remove load center cover screws

C. Remove load center cover

(NOTE: Place the cover out of your working area.)

D. Turn off or pull existing main

(NOTE: Notify the customer that there will be an outage before disconnecting power.)

E. Pull the meter

(NOTE: Turning off the main(s) eliminates an arc during this process.)

F. Remove fasteners securing load center to studs

(CAUTION: If it is secured by screws use extreme care when working around load center interior.)

(NOTE: Use hacksaw blade with tape for a handle or a nail saw to cut nails between load center and stud.)

G. Trace outline for new load center

1. Hold new load center over existing one

(NOTE: Match up knockouts so your panel will fit over existing feeder raceway. You may have to cut an opening.)

JOB SHEET #1

2. Draw around load center once it is in place (Figure 1)

   (NOTE: Make opening about 1/4" large on top and bottom of the panel.)

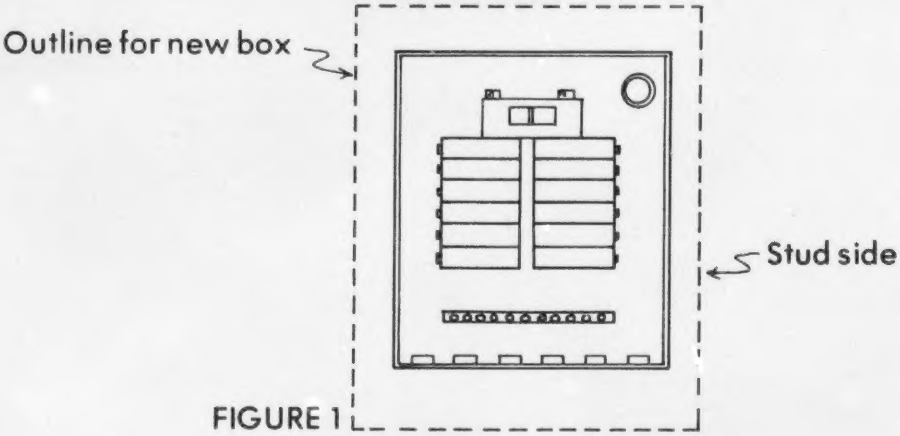


FIGURE 1

H. Cut opening for new load center

   1. Cut lightly along line with knife

   2. Repeat cuts until cut is over one half way through plasterboard

      (NOTE: Do not use a saw until it is evident there are no wires that could be cut.)

   3. Break out plasterboard

      (NOTE: Dress the opening with the keyhole saw.)

I. Disconnect the service entrance conductors from the load center line lugs

J. Disconnect the grounded conductor

   (NOTE: Grounded conductors are always last off and first back on for safety purposes.)

K. Disconnect all wires from branch circuit breakers

   (NOTE: Label all circuits so you can update new circuit directory.)

JOB SHEET #1

L. Disconnect all grounded and grounding wires from block

M. Remove all locknuts and bushings

N. Slip all branch circuit cables out of load center

(NOTE: This may not be possible until you start pulling the panel from the opening.)

O. Pull load center out of opening

P. Lay old load center out of the way

Q. Punch out appropriate KO's for feeder and branch circuits

R. Hold panel up to opening

S. Start branch circuit cables into openings (Figure 2)

(NOTE: Readjust cable connectors before starting cables into the panel.)

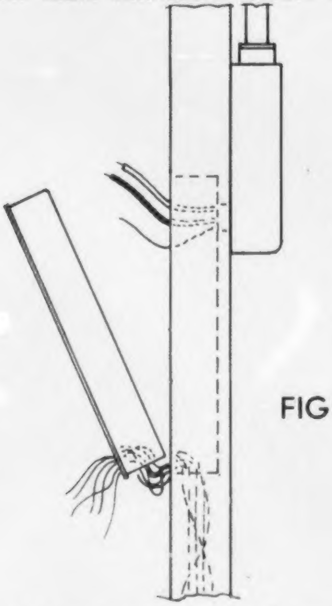


FIGURE 2

T. Feed cables in as you move the load center into place

(NOTE: Proceed carefully so you do not damage any cables.)

U. Guide service entrance conductors into opening

V. Move load center into place

W. Replace locknut and bushing

(NOTE: Bond equipment according to the NEC and local codes.)

JOB SHEET #1

X. Secure load center

(NOTE: Screws are recommended for this job.)

Y. Reconnect service neutral

Z. Reconnect ungrounded service entrance conductors

(NOTE: If these conductors are not long enough replace them.)

AA. Reconnect branch circuits

(NOTE: Be sure and hook conductors to appropriate size breaker.)

BB. Turn all disconnects off

CC. Replace meter

DD. Turn on main(s)

EE. Turn on branch circuit

FF. Check circuits

GG. Put all covers and trims in place

LOAD CENTER CHANGES
UNIT III

JOB SHEET #2--INSTALL A RAINPROOF LOAD CENTER TO SUPPLEMENT AN EXISTING INTERIOR LOAD CENTER

(NOTE: There are many variables involved in this project. It is highly possible that you could do ten jobs like this and have all of them be different. This is only one application; keep in mind there could be many more. This job sheet is an example of one way to increase circuit capacity for a service when the load calculations show the amperage rating will accept your additional circuits.)

I. Tools and equipment

A. Pouch tools

B. Rainproof load center

(NOTE: The number of circuits needed, and type of disconnect already employed will determine whether this load center needs to have a main.)

C. Feeder wire

(NOTE: Size will be determined by service ampacity and use of the load center.)

D. Raceway to connect load center

(NOTE: If the connection is made with conduit you will need fittings, if made with rigid metal conduit you will need locknuts and bushings.)

E. Fasteners

(NOTE: Screws and anchors should be used on concrete or bricks; metal tapping or wood screws will work on wood.)

F. Safety glasses

G. Pencil

H. Leather gloves

I. Voltmeter

J. Auxiliary light

K. Portable GFI

L. Drill motor and masonry bit

M. Leather gloves

JOB SHEET #2

N. Wooden ladder

O. Service connectors

(NOTE: If the utility company disconnects the drop these will not be needed.)

P. Close nipple

(NOTE: The size of this equipment will be determined by the size of the conductors to be installed.)

Q. Four locknuts to fit nipple

R. Two bushings to fit nipple

S. Feeder wire

(NOTE: This includes ungrounded and grounded; size will be determined by service size.)

II. Procedure

(NOTE: Contact the utility company before you start this project. They may want to disconnect the service drop from the service entrance conductors.)

A. Gather tools and equipment

B. Put on safety glasses

C. Notify customer that there will be a temporary outage

(NOTE: Make sure you will not be disrupting the operation of any life sustaining equipment.)

D. Disconnect the service drop

(NOTE: Be sure to:
1. Work from a wooden ladder
2. Wear gloves
3. Disconnect one conductor at a time
4. Tape conductors as you remove them
5. Remove neutral last.)

E. Loosen straps connecting riser to structure

F. Remove meter base cover

G. Remove screws securing meter base

JOB SHEET #2

H. Remove ungrounded conductors from load side (Figure 1)

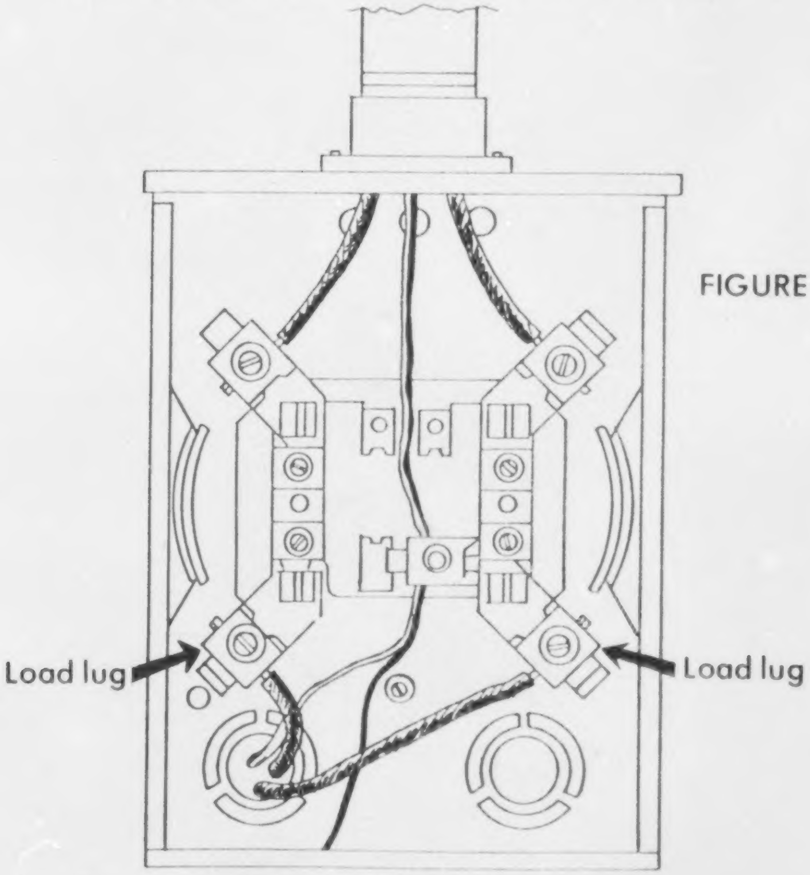


FIGURE 1

I. Remove grounded and grounding conductors

J. Remove bushing and locknuts

K. Straighten conductors

L. Pull meter base straight out and over conductors

M. Lift meter base out of way

N. Remove appropriate KO from new load center

(NOTE: If it is going to put the meter higher than the utility company will allow when you use a bottom KO use a top one instead. You may have to cut a new one.)

O. Put load center over conductors

P. Mark securing screw locations

JOB SHEET #2

Q. Mount the load center

(NOTE: Be sure and use GFI if holes are to be drilled.)

R. Install locknuts and bushings

(NOTE: Check on bonding requirements with local utility company.)

S. Install nipple between new load center and meter base using backup locknuts on the outside of both enclosures.

(NOTE: It may be that you will have to mount the meter base to the side of your panel instead of above it. See Figure 2. Look the situation over carefully before you decide.)

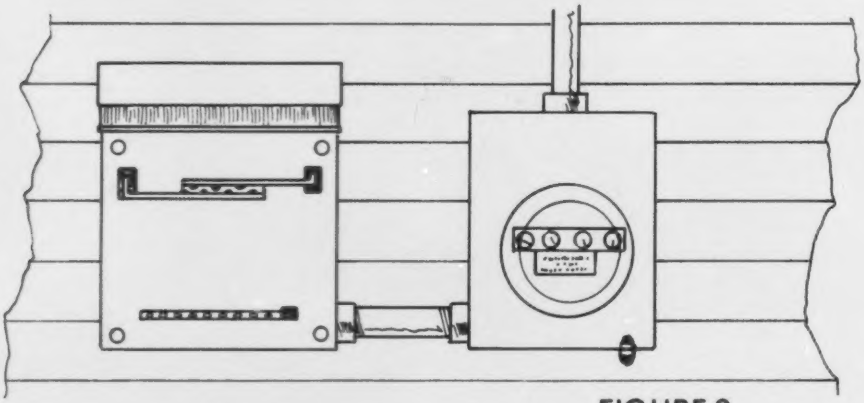


FIGURE 2

T. Secure meter base

U. Install interior locknuts and bushings

(NOTE: Check with local utility company on bonding requirements.)

V. Install conductors between existing panel and new load center

(NOTE: Size is determined by load and equipment rating. Provide overcurrent protection for existing panel from new load center.)

W. Install conductors between meter load lugs and new load center line lugs

X. Reconnect grounding electrode conductor

JOB SHEET #2

Y. Resecure service riser

Z. Reconnect service drop

(NOTE: Consult your local utility company; they may want to do this. Always remember:

1. Grounded conductor is last off and first back on
2. Wear gloves
3. Work one conductor at a time
4. Tape conductor as it is connected
5. Don't carry extra tools in your hands
6. Work from a wooden ladder.)

AA. Turn off main breaker(s)

BB. Install meter

CC. Turn on breakers

DD. Check circuits

EE. Update circuit directory

FF. Clean up area

LOAD CENTER CHANGES
UNIT III

JOB SHEET #3--INSTALL A FUSIBLE SAFETY SWITCH FOR AN AIR-CONDITIONING CONDENSER

(NOTE: This job sheet deals only with the mounting of the disconnect. The supply line to the unit is sometimes installed by the air-conditioning installer and sometimes by the electrician.)

I. Tools and equipment

A. Pouch tools

B. Raintight fusible safety switch

(NOTE: Size of the switch will be determined by the full load or running amperage of the unit.)

C. Connecting equipment for switch

(NOTE: If this is a new house a rigid metal conduit or EMT nipple should have been installed during the rough-in and should be extending just beyond the surface of the exterior wall.)

D. Fasteners

(NOTE: Anchors and screws will be required for brick or concrete; wood screws will work on woodsiding.)

E. Safety glasses

F. Pencil

G. Drill motor and appropriate bit

H. GFI

II. Procedure

(NOTE: Check to be sure the circuit is not live.)

A. Gather tools and equipment

B. Mark mounting holes for switch

(NOTE: Remember the switch must be within sight of the unit and readily accessible.)

JOB SHEET #3

C. Connect supply raceway or connector to switch

(NOTE: 1, 2, and 3 are three possible rough-in techniques that could be encountered.)

1. Cable only visible

    a. Situate cable so not in a bind

    b. Install a seal tight clamp on the cable

    c. Connect cable to box

    (NOTE: You may have to chisel around the cable to allow the connector freedom.)

2. Rigid conduit with threads

    a. Adjust conduit so appropriate amount extends inside the box

    (NOTE: There should be enough to install a locknut and a bushing.)

    b. Install back up locknut

    c. Install interior locknut and bushing

3. EMT

    a. Put a raintight connector on EMT

    b. Adjust conduit so switch fits flat against wall

D. Secure switch to the wall

(NOTE: If holes need to be drilled be sure and use GFI.)

E. Connect grounded conductor

(NOTE: If a bar or lug is not supplied you can mount a lug.)

F. Connect ungrounded conductors

G. Activate circuit

H. Test across and between line lugs

I. Close cover

LOAD CENTER CHANGES
UNIT III

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. Refrigeration equipment that sits outside a residential dwelling and is used to remove heat from refrigerant; usually contains a hermetically sealed compressor

_____b. Amperage at which system is designed to operate

_____c. Equipment necessary to keep patients alive

_____d. Period during which no current is available to circuits in a residential dwelling

1. Full load amps (F.L.A.)
2. Outage
3. Life sustaining medical equipment
4. Air conditioning condenser

2. List four possible ways to increase service size on an existing dwelling.

a.

b.

c.

d.

3. List five procedures for changing an existing residential service.

a.

b.

c.

d.

e.

4. Demonstrate the ability to:

   a. Replace an existing interior flush mount load center.

   b. Install a rainproof load center to supplement an existing interior load center.

   c. Install a fusible safety switch for an air-conditioning condenser.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

LOAD CENTER CHANGES
UNIT III

ANSWERS TO TEST

1. a. 4

   b. 1

   c. 3

   d. 2

2. a. Install larger service entrance conductors in existing raceways and increase load center main breaker

   b. Install complete new service entrance conductors, raceway and weather head, and change load center interior

   c. Make a complete service change out

   d. Increase service entrance conductor size and set a new exterior load center to feed existing panel as a sub

3. a. Calculate service size needed

   b. Estimate materials and labor needed

   c. Consult with customer about best possible time to do the work

   d. Contact utility company about the project

   e. Start and complete project

4. Performance skills evaluated to the satisfaction of the instructor

TROUBLESHOOTING
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to troubleshoot an electrical system problem. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define troubleshooting.
2. Select requirements for a correctly operating safe residential system.
3. List seven basic troubleshooting procedures.
4. Discuss the importance of understanding troubleshooting procedures.
5. Demonstrate the ability to troubleshoot an electrical system problem.

TROUBLESHOOTING
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide student with objective sheet.
- B. Provide student with information and job sheets.
- C. Discuss unit and specific objectives.
- D. Discuss information and job sheets.
- E. Show students examples of troubleshooting.
- F. Discuss troubleshooting charts.
- G. Invite a potential employer to discuss importance of sound troubleshooting techniques.
- H. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Complete job sheet.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Job Sheet #1--Troubleshoot an Electrical System Problem
- D. Test
- E. Answers to test

TROUBLESHOOTING
UNIT I

INFORMATION SHEET

I. Troubleshooting--The systematic diagnosis of malfunctions

II. Requirements for a correctly operating safe residential system

   A. Adequate service

      (NOTE: A system that has been continually added to without a service size increase can be a constant source of trouble.)

   B. Proper overcurrent sizing

      (NOTE: Too large or too small overcurrent equipment can cause problems.)

   C. Properly maintained appliances, illumination systems, and equipment

      (NOTE: Unoiled motors, oversized bulbs, and all improperly installed equipment can cause problems.)

   D. Meets or exceeds NEC standards

III. Basic troubleshooting procedures

   A. Know the system

      (NOTE: You cannot efficiently troubleshoot unless you know how the system operates.)

   B. Ask the owner about the problem

      (NOTE: The owner can tell you about symptoms and problems that occurred during system operation.)

   C. Inspect the system

      (NOTE: Quite often problem spots can be seen or smelled.)

   D. Activate the system if safely possible

      (NOTE: Often the system must be activated in order to make tests; always be careful around live circuits.)

   E. List possible causes

      (NOTE: Put down all the symptoms and visible possibilities.)

INFORMATION SHEET

F. Formulate a conclusion

(NOTE: Remember when looking at the list of possible causes that one failure often leads to or indicates another problem.)

G. Test conclusion

(NOTE: Before you start repairing the system analyze the information you have and test your conclusion if possible. Be a troubleshooter, not a hit and miss person. Always be safety conscious.)

IV. Importance of understanding troubleshooting procedures

A. Saves customer's money

(NOTE: The alternative to troubleshooting is equipment exchanging. If you don't solve the problem on first or second exchange it gets expensive.)

B. Insures a better repair job

1. Total system is observed

(NOTE: This provides more opportunity to find weak or failing equipment.)

2. Better operating dependability

(NOTE: Thorough troubleshooting provides for the identification of problems which may hinder proper system operations in the future.)

3. Makes a safer job

C. Makes employees more valuable

1. Good service means continued business with present customers plus the drawing of new customers

2. Less work is redone

TROUBLESHOOTING
UNIT I

JOB SHEET #1--TROUBLESHOOT AN ELECTRICAL SYSTEM PROBLEM

(NOTE: This is a general job sheet designed to provide practice in using sound troubleshooting procedures.)

I. Tools and materials

  A. Pouch tools

  B. Volt-ohm-ammeter

  C. Safety glasses

  D. Auxiliary lighting

II. Procedure

  A. Familiarize yourself with the system

    1. Locate supply panel and any subpanels or disconnects

    2. Know system voltage and other data

    3. Trace circuits out mentally and physically if possible

  B. Ask the owner about the problem

    1. Ask about performance prior to the problem

    2. Ask about problem symptoms

    3. Inquire about maintenance procedures

    4. Ask if this problem has happened before

  C. Inspect the system

    1. Look for discolorations on equipment

    2. Smell for unusual odors

    3. Look for frayed cords

    4. Watch for improperly installed or connected appliances

  D. Operate the system if safely possible

    1. Turn off switches

    2. Unplug appliances

    3. Check voltages

JOB SHEET #1

E. List possible problem causes

(NOTE: Use your knowledge of the system plus information received from the troubleshooting techniques used to this point.)

F. Formulate a conclusion

1. Review list of probable causes
2. Select cause

G. Test conclusion

(NOTE: Test the conclusion you have reached before repairing the system if possible.)

TROUBLESHOOTING
UNIT I

NAME ____________________

TEST

1. Define troubleshooting.

2. Select requirements for a correctly operating safe residential system.

   _____a. Adequate service

   _____b. Proper overcurrent sizing

   _____c. Metal plates on all outlets

   _____d. Properly maintained appliances, illumination systems, and equipment

   _____e. Keyless cover sockets in all closets

   _____f. Meets or exceeds NEC standards

3. List seven basic troubleshooting procedures.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

4. Discuss the importance of understanding troubleshooting procedures.

5. Demonstrate the ability to troubleshoot an electrical system problem.

   (NOTE: If this activity has not been accomplished prior to the test, ask your instructor when it should be completed.)

TROUBLESHOOTING
UNIT I

ANSWERS TO TEST

1. The systematic diagnosis of malfunctions
2. a, b, d, f
3. a. Know the system
   b. Ask the owner about the problem
   c. Inspect the system
   d. Activate the system if safely possible
   e. List possible causes
   f. Formulate a conclusion
   g. Test conclusion
4. Discussion should include:
   a. Saves customer's money
   b. Insures a better repair job
      1) Total system is observed
      2) Better operating dependability
      3) Makes a safer job
   c. Makes employees more valuable
      1) Good service means continued business with present customers plus the drawing of new customers
      2) Less work is redone
5. Performance skill evaluated to the satisfaction of the instructor.

TAKE OFF AND ESTIMATE
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to estimate the equipment needed to wire a residential dwelling. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with take-off and estimating practices to the correct definitions.
2. Discuss two methods of estimating residential wiring bids.
3. List four factors that cause a change in a residential wiring bid.
4. Determine material retail prices when given wholesale prices.
5. Estimate material needed for installing a residential service.
6. Estimate material needed for installing appliance circuits in a residential dwelling.
7. Estimate material needed for installing general purpose branch circuits in a residential dwelling.

TAKE OFF AND ESTIMATE
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and assignment sheets.

  C. Discuss unit and specific objectives.

  D. Discuss information and assignment sheets.

  E. Show students wholesale catalogs.

  F. Take field trip to wholesale house.

  G. Give test.

II. Students:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete assignment sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Assignment sheets

    1. Assignment Sheet #1--Determine Material Retail Prices When Given Wholesale Prices

    2. Assignment Sheet #2--Estimate Material Needed for Installing a Residential Service

3. Assignment Sheet #3--Estimate Material Needed for Installing Appliance Circuits in a Residential Dwelling

4. Assignment Sheet #4--Estimate Material Needed for Installing General Purpose Branch Circuits in a Residential Dwelling

D. Answers to assignment sheets

E. Test

F. Answers to test

TAKE OFF AND ESTIMATE
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Retail--Price paid by consumer for a product; equal to wholesale plus contractor mark-up

B. Wholesale--Price paid by a contractor for a product

C. Bid--Price offered to consumer by contractor for a given amount of goods and services

D. M--Roman numeral for 1,000

E. C--Roman numeral for 100

F. Mark-up--Amount added on to wholesale to bring price to retail; usually expressed as a percentage

G. Manhours--Actual number of expended wage earning hours

Example: Two men for 8 hrs. = 16 manhours for billing purposes

H. Specifications--Written list describing quality and quantity of equipment to be installed

II Methods of estimating residential wiring bids

A. Per outlet bid

1. Uses general figure per outlet

(NOTE: This figure is based on the average cost of installing outlets plus a predetermined amount for labor.)

Example:

$ 5.50	=	Equipment	(box, cable, staples, device, etc.)
6.00	=	Labor	
$11.50		Per Outlet	

2. Service equipment is a supplementary charge

(NOTE: This is usually on a per ampere basis.)

Example:

$ 200.00	=	$ 1.00 x 200 amperes
72.00	=	$12.00 x 6 manhours
$ 272.00	=	Service price

INFORMATION SHEET

3. 240 volt circuits are calculated individually

4. The bid usually reflects past performance and prices

B. Itemized bid

1. All materials are counted

(NOTE: All boxes, staples, panels, wire, clamps and devices are counted for the bid.)

2. Manhours are estimated separately

3. The bid usually reflects a cost close to current prices

(NOTE: The itemized bid is more time consuming but also is a safer bid.)

III. Factors that cause a change in a residential wiring bid

A. Additional outlets requested by customer

B. Utility company mandated changes

(NOTE: If the specifications called for an overhead service, but the utility company will only supply underground, the cost could go up.)

C. Changes mandated by code enforcing agency

(NOTE: City or state inspectors may have requirements above the specifications as bid on.)

D. Delayed acceptance of bid

TAKE OFF AND ESTIMATE
UNIT II

ASSIGNMENT SHEET #1–DETERMINE MATERIAL RETAIL PRICES WHEN GIVEN WHOLESALE PRICES

Directions: Determine the unit price, then add 35% mark-up. Round off to nearest cent.

Example:

Retail Price	Description	Wholesale Price
12¢ per ft.	12-2 GNM Cable	$ 86.00/M'

Calculations:

$ .086 per ft.
1000 |$86.00 per thousand feet

$ .086 per ft. wholesale
x 1.35 mark up
$ .1161 per ft. retail

Problems:

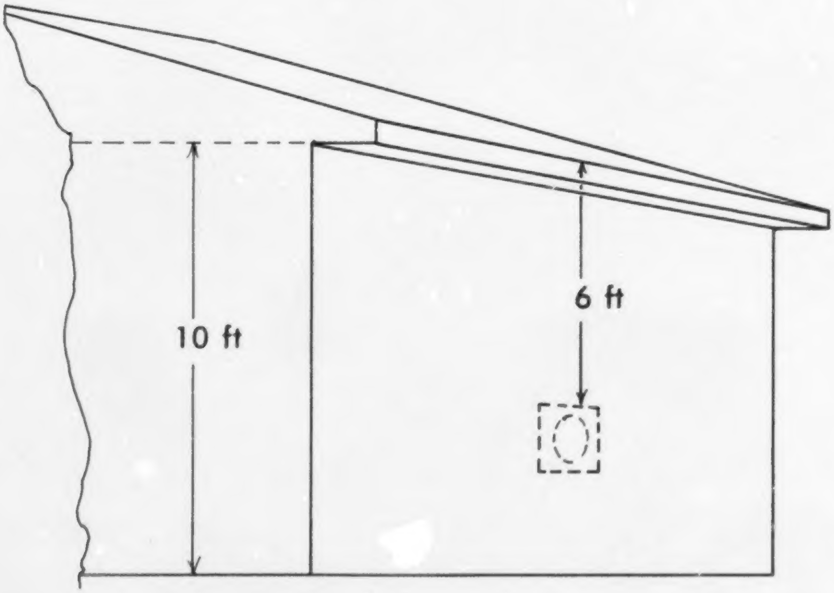
	Retail Price		Description	Wholesale Price
1.	__________	each	Duplex Grounding Receptacle	$ .66
2.	__________	each	SP Switch	$ .65
3.	__________	each	GFI Receptacle	$ 25.87
4.	__________	each	Wing Nut Wire Connector	$ 1.56 / C'
5.	__________	per ft.	18-2 Thermostat Cable	$ 26.46 / M'
6.	__________	each	S P Dimmer Switch	$ 4.12
7.	__________	each	30 Amp Fusible Safety Switch	$ 7.05
8.	__________	each	Sheet Metal Screw	$ 7.76 / M'
9.	__________	each	Vinyl Electrical Tape	$ 3.77 / 12 roll can
10.	__________	each	Photoelectric Switch	$ 8.35

TAKE OFF AND ESTIMATE
UNIT II

ASSIGNMENT SHEET #2--ESTIMATE MATERIAL NEEDED FOR INSTALLING A RESIDENTIAL SERVICE

Directions: From the description of the dwelling given below compile a list of all equipment needed to install the service entrance. The numbers on your answer sheet do not mean there are that many pieces needed.

Description of residence: The house is a wood frame dwelling and will be supplied by a service drop run to the dwelling by the utility company. The owner specified a 30 circuit 200 amp service. It is 6' from the top of where the meter base is to be located to the roof top directly above it. The utility company requests a driven ground rod.



ASSIGNMENT SHEET #2

1.
2.
3.
4.
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11.
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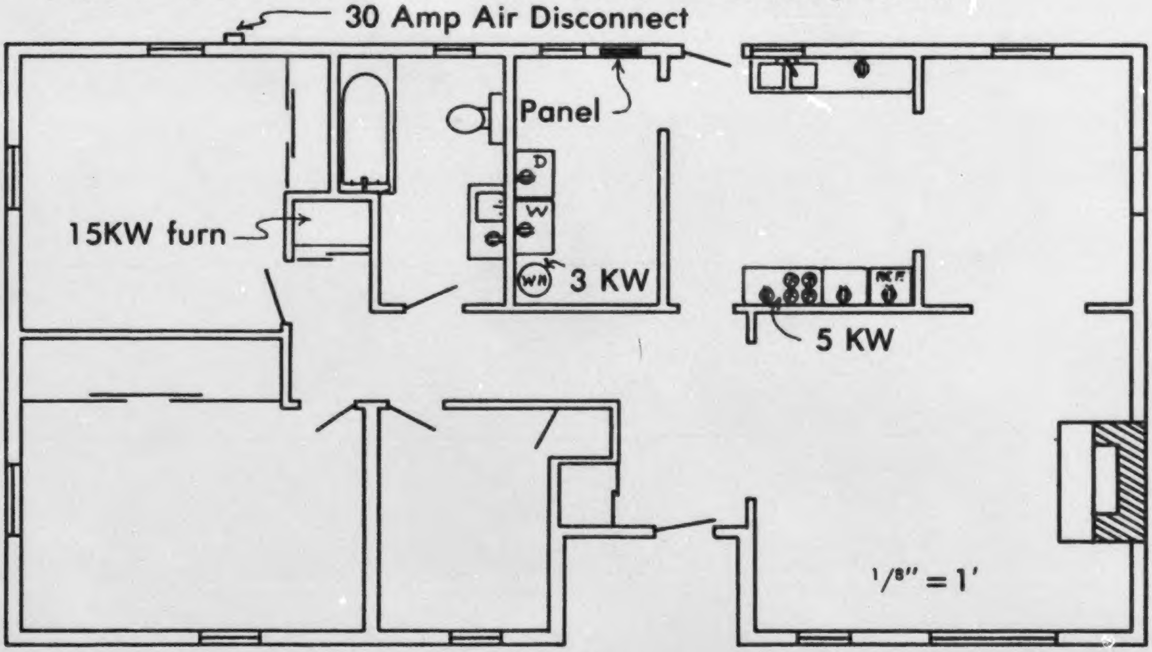
13.
14.
15.
16.
17.
18.
19.
20.
21.
22.
23.
24.

TAKE OFF AND ESTIMATE
UNIT II

ASSIGNMENT SHEET #3--ESTIMATE MATERIAL NEEDED FOR INSTALLING APPLIANCE CIRCUITS IN A RESIDENTIAL DWELLING

(NOTE: This assignment sheet is intended to assist students in gathering necessary equipment, not calculating costs.)

Directions: Estimate cable footage, boxes (sizes and accessories should be listed with box description), number of staples, breakers, devices, cable clamps and all other equipment needed to install the circuits listed below. Assume that the ceilings are 8'.



Estimate equipment needed for these circuits

1. 15 KW Furnace:

2. 3 KW water heater:

3. Laundry circuit:

4. Dryer circuit:

ASSIGNMENT SHEET #3

5. Small appliance circuit:

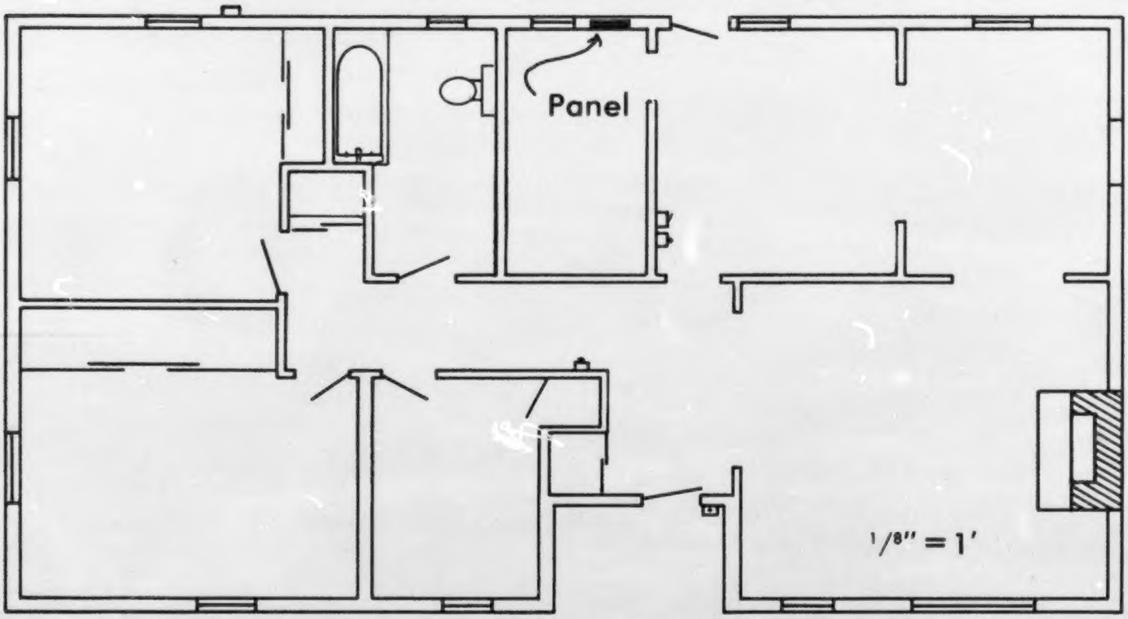
6. Refrigerator circuit:

7. Air conditioning condenser:

TAKE OFF AND ESTIMATE
UNIT II

ASSIGNMENT SHEET #4--ESTIMATE MATERIAL NEEDED FOR INSTALLING GENERAL PURPOSE BRANCH CIRCUITS IN A RESIDENTIAL DWELLING

Directions: Estimate all the equipment you would need to gather to wire the general purpose branch circuits for the project below. List boxes by type (device, octagon square) and size, cable by type and footage, breakers by amperage and pole, and devices by type. Wire it to NEC minimum standards.



Cable:

Boxes and Hangers:

Devices:

Staples:

ASSIGNMENT SHEET #4

Wire connectors:

Cable clamps:

Breakers (include GFI equipment if not listed under devices):

Other equipment:

TAKE OFF AND ESTIMATE
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. $.89
2. $.88
3. $34.92
4. $.02
5. $.04
6. $5.56
7. $9.52
8. $.01
9. $.42
10. $11.27

Assignment Sheets #2, 3, and 4

Evaluated to the satisfaction of the instructor

TAKE OFF AND ESTIMATE
UNIT II

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions or descriptions.

_____a. Price paid by consumer for a product; equal to wholesale plus contracter mark-up

_____b. Price paid by a contracter for a product

_____c. Price offered to consumer by contracter for a given amount of goods and services

_____d. Roman numeral for 1,000

_____e. Roman numeral for 100

_____f. Amount added on to wholesale to bring price to retail; usually expressed as a percentage

_____g. Actual number of expended wage earning hours

_____h. Written list describing quality and quantity of equipment to be installed

1. C
2. Mark-up
3. Specifications
4. Retail
5. Bid
6. M
7. Wholesale
8. Manhours

2. Discuss two methods of estimating residential wiring bids.

3. List four factors that cause a change in a residential wiring bid.
    a.
    b.
    c.
    d.
4. Determine material retail prices when given wholesale prices.
5. Estimate material needed for installing a residential service.
6. Estimate material needed for installing appliance circuits in a residential dwelling.
7. Estimate material needed for installing general purpose branch circuits in a residential dwelling.

TAKE OFF AND ESTIMATE
UNIT II

ANSWERS TO TEST

a. 4
b. 7
c. 5
d. 6
e. 1
f. 2
g. 8
h. 3

2. Discussion should include:
   a. Per outlet bid
      1. Uses general figure per outlet
      2. Service equipment is a supplementary charge
      3. 240 volt circuits are calculated individually
      4. The bid usually reflects past performances and prices
   b. Itemized bid
      1. All materials are counted
      2. Manhours are estimated separately
      3. The bid usually reflects a cost close to current prices

3. a. Additional outlets requested by customer
   b. Utility company mandated changes
   c. Changes mandated by code enforcing agency
   d. Delayed acceptance of bid

4. Evaluated to the satisfaction of the instructor

5. Evaluated to the satisfaction of the instructor

6. Evaluated to the satisfaction of the instructor

7. Evaluated to the satisfaction of the instructor

CUSTOMER SERVICE
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to select information about personality traits, and list the types of information needed from a telephone conversation and information on how to avoid legal problems while working for a customer. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with customer service to the correct definitions.
2. Select personality traits that are important when dealing effectively with customers.
3. List three differences in customers that could effect the way you deal with them.
4. List four items of information that should be acquired during a telephone conversation with a customer.
5. Select things a customer expects from an electrician.
6. List six ways to avoid legal problems in equipment installation and repair.

CUSTOMER SERVICE
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information sheet.

  C. Discuss unit and specific objectives.

  D. Discuss information sheet.

  E. Invite local inspector in to discuss inspection practices.

  F. Invite a bond underwriter to discuss bonding and liability coverages.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet

  C. Participate in discussions.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Test

  D. Answers to test

CUSTOMER SERVICE
UNIT III

INFORMATION SHEET

I. Terms and definitions

- A. Personality--The sum of all specific traits that are noticeably consistent in an individual's behavior
- B. Customer service--Business functions including communications, sales, and repair as well as custom work
- C. By-pass--Intentional removal of a circuit component by completing a circuit around it
- D. U.L. listed--Designates equipment that has been tested and determined to meet certain requirements according to Underwriter's Laboratories

II. Important personality traits when dealing effectively with customers

- A. Polite
- B. Cheerful
- C. Friendly
- D. Tactful
- E. Self-confident

III. Differences in customers that could effect the way you deal with them

- A. Backgrounds
- B. Attitudes
- C. Abilities

IV. Information acquired during a telephone conversation with a customer

(NOTE: When speaking on the telephone you should always use a pleasant tone of voice, speak clearly, and identify your company and yourself.)

Example: "Smith Electric, Pat Jones speaking."

- A. Name and address of the customer
- B. Exact description of problem or work to be done

INFORMATION SHEET

C. Date and time work is needed

D. Billing instructions

(NOTE: Employers often require more information. Consult your employer before making telephone commitments to a customer.)

V. Things a customer expects from an electrician

A. Steady work

(NOTE: Customers expect you to work while on their time; they do not want to pay you for conversation or smoke and coffee breaks.)

B. Neat work

(NOTE: Don't leave cracked plates, loose fixtures or any other bad trademarks behind.)

C. A clean area when work is completed

(NOTE: Always put papers or a drop cloth down when dust or chips will be falling from your work onto carpets or finished floors. Wash walls if you have left hand prints.)

D. Good personality

(NOTE: You should always extend a friendly greeting and a polite thank you when finished.)

VI. Ways to avoid legal problems in equipment installation and repair

A. Use equipment that is listed by a national testing organization

(NOTE. If equipment has a listing such as U. L. it is backed by their legal counsel and engineering experts. On unlisted material you may be responsible for this information.)

B. Install all wiring to code and customer specifications

C. Always install equipment as it was designed and listed

(NOTE: Incorrect use of equipment can cause a loss of its listing which could cause legal problems.)

D. Don't install equipment unless you know how it should be installed

(NOTE: It is easier to consult someone on installation requirements than legal responsibilities.)

INFORMATION SHEET

E. Never by-pass or jump a part

(NOTE: In case of fires or personal injury, by-passes such as copper links for fuses show up even after a bad fire.)

F. Replace panel covers and screws, as well as any other equipment needed to make a safe installation

CUSTOMER SERVICE
UNIT III

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. The sum of all specific traits that are noticeably consistent in an individual's behavior

_____b. Intentional removal of a circuit component by completing a circuit around it

_____c. Business functions including communications, sales, and repair as well as custom work

_____d. Designates equipment that has been tested and determined to meet certain requirements according to Underwriter's Laboratories

1. Personality
2. Customer service
3. By-pass
4. U. L. listed

2. Select personality traits that are important in dealing effectively with customers by placing an "X" in the appropriate blanks.

_____a. Polite

_____b. Boastful

_____c. Friendly

_____d. Tactful

_____e. Cheerful

_____f. Self-confident

3. List three differences in customers that could effect the way you deal with them.

a.

b.

c.

4. List four items of information that should be acquired during a telephone conversation with a customer.

   a.

   b.

   c.

   d.

5. Select things a customer expects from a electrician by placing an "X" in the appropriate blanks.

   _____a. Steady work

   _____b. Small talk

   _____c. Neat work

   _____d. A clean area when work is completed

6. List six ways to avoid legal problems in equipment installation and repair.

   a.

   b.

   c.

   d.

   e.

   f.

CUSTOMER SERVICE
UNIT III

ANSWERS TO TEST

1. a. 1
   b. 3
   c. 2
   d. 4
2. a, c, d, e, f
3. a. Backgrounds
   b. Attitudes
   c. Abilities
4. a. Name and address of the customer
   b. Exact description of problem or work to be done
   c. Date and time work is needed
   d. Billing instructions
5. a, c, d
6. a. Use equipment that is listed by a national testing organization
   b. Install all wiring to code and customer specifications
   c. Always install equipment as it was designed and listed
   d. Don't install equipment unless you know how it should be installed
   e. Never by-pass or jump a part
   f. Replace panel covers and screws, as well as any other equipment needed to make a safe installation

APPLYING FOR A JOB
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to locate a job opening, make formal application, and interview for a job. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with job application to the correct definitions.
2. List means of locating job openings.
3. List three methods of applying for a job.
4. Select items of information that may be asked for on an application.
5. Distinguish between employer and employee expectations.
6. Select the attributes or attitudes an employer looks for during a personal interview.
7. Select examples of proper conduct during the job interview.
8. Demonstrate the ability to:
   a. Prepare a resume.
   b. Write a letter of application for a residential wiring job.
   c. Complete an application form for a job as a residential electrician.
   d. Write a follow-up letter after an interview for a residential wiring job.

APPLYING FOR A JOB
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information and assignment sheets.

C. Discuss unit and specific objectives.

D. Discuss information and assignment sheets.

E. Provide samples of various application forms.

F. Invite a personnel director to discuss job interviewing techniques.

G. Ask students to describe a well groomed, appropriately dressed residential electrician.

H. Lead discussion on reasons why some people lose their jobs.

I. Provide opportunity to take sample employment test.

J. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete assignment sheets.

D. Describe a well groomed, appropriately dressed residential electrician.

E. Discuss reasons why people lose their jobs.

F. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Assignment sheets

   1. Assignment Sheet #1--Prepare a Resume

   2. Assignment Sheet #2--Write a Letter of Application for a Residential Wiring Job

   3. Assignment Sheet #3--Complete an Application Form for a Job as a Residential Electrician

   4. Assignment Sheet #4--Write a Follow-Up Letter After an Interview for a Residential Wiring Job

D. Test

E. Answers to test

II. References:

A. Blackledge, Walter L.; Blackledge, Ethel H.; and Keely, Helen J. *You and Your Job.* Cincinnati: South-Western Publishing Company, 1967.

B. Kimbrell, Grady, and Vineyard, Ben S. *Succeeding in the World of Work.* Bloomington, Illinois: McKnight and McKnight Publishing Company, 1970.

C. *Occupational Child Development.* Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1975.

D. *Commercial Carpentry.* Stillwater, Oklahoma: Curriculum and Instructional Materials Center/State Department of Vocational and Technical Education, 1974.

APPLYING FOR A JOB
UNIT IV

INFORMATION SHEET

I. Terms and definitions

   A. Awards--Recognition received for outstanding achievement

   B. Extra-curricular activities--The clubs, organizations, and social or church groups in which one participates

   C. Fringe benefits--The extras provided by an employer such as paid vacations, sick leave, and insurance protection

   D. Qualifications--The experience, education, and physical characteristics which suit a person to a job

   E. Resume--A brief typed summary of one's qualifications and experiences that is used in applying for a job

   F. Vocational preparation--Any vocational courses taken and skills one has learned in school or through work experience

II. Means of locating job openings

   A. Classified ads

   B. Employment offices

   (NOTE: You can use state employment offices or private offices.)

   C. Local labor union business office

   D. School officials

   (NOTE: Your teacher and counselor or employment coordinator will be glad to help you.)

   E. Workers in residential wiring occupation

   (NOTE: Current workers will know of openings that are sometimes not printed anywhere.)

III. Methods of applying for a job

   A. Letter

   B. Telephone

   C. In person

INFORMATION SHEET

IV. Information that may be asked for on an application

A. Name and address

B. Phone number

C. Social security number

D. Age, height, weight

E. Education

F. Experience

G. Next of kin

H. Previous employers

I. Reason for leaving last job

J. Type of job for which one is applying

K. References

L. Resume (optional)

M. General physical health

V. Expectations of the employer and employee

A. Employer expects

1. Cooperation
2. Honesty
3. Initiative
4. Willingness to learn
5. Willingness to follow directions
6. Dependability
7. Enthusiasm
8. Acceptance of criticism
9. Loyalty and respect
10. Full day's work for a full day's pay
11. Notification of termination

INFORMATION SHEET

B. Employee expects

  1. Salary
  2. Safe working conditions
  3. Training
  4. Introduction to co-workers
  5. Explanation of policies, rules, and regulations
  6. Duty changes
  7. Evaluation of work
  8. Discipline for breaking rules
  9. Honest relationship
  10. Notification if employment is terminated
  11. Respect

VI. Personal attributes or attitudes

A. Enthusiasm and interest

(NOTE: This includes taking pride in your work and being willing to do your share or more if needed.)

B. Dedication and dependability

(NOTE: This involves being at work on time and regularly. It also means you should follow directions readily.)

C. Alertness, quickness of mind

(NOTE: You should always look out for dangerous situations that could injure workers or damage property. You should be constantly looking for more efficient working practices.)

D. Honesty and integrity

(NOTE: All employees should give truthful information, both to their employer and customers.)

E. Desire to work

INFORMATION SHEET

F. Desire to help others

G. Desire to improve one's self

(NOTE: Good employees are always looking for ways to increase their knowledge. It will benefit both the employer and the employee.)

VII. Proper conduct during the interview

A. Greet interviewer with a warm smile

B. Call interviewer by name (Mr., Mrs., or Miss Jones)

C. Introduce self

D. Shake interviewer's hand firmly

E. Be seated only after interviewer has asked you to be seated

F. Sit and stand erect; do not lean against the wall, a chair, or the desk

G. Do not put a hat or coat on the interviewer's desk

H. Let the interviewer take the lead in the conversation

I. Answer questions completely

J. Be polite and courteous

(NOTE: Do not interrupt. Say "Yes, sir/ma'am" or "No, sir/ma'am" when addressed.)

K. Have resume and examples of work available for quick reference

L. Make an extra effort to express one's self clearly and distinctly

(NOTE: Take time to think through every answer, use proper grammar, do not swear, avoid use of slang, and look the interviewer in the eye.)

M. Be sincere and enthusiastic

N. Avoid irritating or distracting habits

(NOTE: This includes such things as smoking, chewing gum, eating candy, giggling or squirming in chair, finger tapping and/or swinging a crossed leg.)

O. Do not try to flatter the interviewer

INFORMATION SHEET

P. Tell the truth about qualifications and experiences

Q. Speak well or not at all of former employers and associates

R. Be positive

S. Accept competition gracefully

T. Watch for a sign that the interview is over

U. Thank the interviewer

V. Leave promptly at completion of interview

W. Make contacts alone

(NOTE: Taking two or three buddies doesn't help you get a job.)

APPLYING FOR A JOB
UNIT IV

ASSIGNMENT SHEET #1--PREPARE A RESUME

Directions: Prepare a resume using the standards and example provided below as references.

Standards for a resume

1. Logically organized
2. Neatly typed
3. Error free
4. In outline form
5. Limited to one page if possible
6. Honest listing of qualifications and experience

Example:

Name:	Pat L. Smith
Address:	774 E. Adams St., Anywhere, U.S.A. 77704
Telephone:	377-3303
Age:	18 years
Height:	5' - 8"
Weight:	160 pounds
Health:	Excellent
Marital Status:	Single
Education:	Expect to graduate from high school May 1973
Subjects studied:	Residential Wiring--2 years (1080 hours) Algebra--2 semesters Geometry--2 semesters Basic drafting--2 semesters Industrial arts wood working--2 semesters
Student activites:	President, Senior class President, VICA Treasurer, Baptist youth fellowship Residential Wiring contest, 1st place State, 3rd place National
Work experience:	Electrician's helper, Jones Electrical Co., Summer 1972 Residential Wiring Class 1972-73, all phases of Residential Wiring. Mr. Sammy Slavedriver, Instructor

ASSIGNMENT SHEET #1

References:

Mr. Sammy Slavedriver
Residential Wiring Instructor
Anywhere High School
Anywhere, U.S.A. 77704

Mr. John Lotsaspark
Construction Foreman
Jones Electrical Company
2330 Lake Shore Drive
Anywhere, U.S.A. 77704

Mr. Jimmie Smith
Youth Director
Park View Baptist Church
711 Fellowship Circle
Anywhere, U.S.A. 77704

Date compiled ____

Signature ____

APPLYING FOR A JOB
UNIT IV

ASSIGNMENT SHEET #2--WRITE A LETTER OF APPLICATION FOR A RESIDENTIAL WIRING JOB

Directions: Using the letter standards, information to be included, and example write a letter of application.

A. Make sure the letter meets the standards below:

(NOTE: Your instructor will be glad to help you. A typing or business and office class would probably be willing to type for you.)

1. Attractive form
2. Logical arrangement of information
3. Free from smudges or typographical errors
4. Free from spelling or gramatical errors
5. Brief and to the point--Leave the details for the resume
6. Positive in tone
7. Clearly expressed ideas

B. The following information should be included in a letter of application

1. Type of position for which one is applying
2. Reason interested in position and firm
3. Ways one's training meets the employer's needs
4. Explanation of personal qualifications
5. Mention of resume

ASSIGNMENT SHEET #2

Example:

Mr. John Jones
Personnel Director
Jones Electrical Company
Box 19
Anywhere, U.S.A. 77704

Dear Mr. Jones:

Please consider me for the job of residential electrician that you advertised in the Daily Chronicle.

The skills I have learned in my high school vocational residential wiring course should qualify me for this job. I have had experience in all of the basic skills required in residential wiring, including safety.

I will be graduating from high school in May, and I would like to become a residential electrician. A more complete description of my qualifications is given in the enclosed resume.

I would appreciate the opportunity to interview any time at your convenience. I can be reached by phone at 377-3303 after 3:30 p.m. or by mail at 774 East Adams Street, Anywhere, U.S.A. 77704.

Sincerely yours,

Pat L. Smith

Encl. 1

APPLYING FOR A JOB
UNIT IV

ASSIGNMENT SHEET #3--COMPLETE AN APPLICATION FORM FOR A JOB AS A RESIDENTIAL ELECTRICIAN

Fill in every blank, and put "does not apply" in those blanks where information not relevent is requested.

APPLICATION FOR EMPLOYMENT

Date ____________________ Position applied for ____________________

Name ____________________ Height ________ Weight ________ Age _____

Address ____________________ Telephone No. ______________
(Street or RFD) (City) (State)

Social Security No. ____________________

Birthdate ____________________ Birthplace ____________________
(Month) (Day) (Year) (City) (State)

CHECK ALL THAT APPLY:

_____ Female
_____ Male
_____ Single
_____ Married
_____ Widowed
_____ Divorced
_____ Separated

_____ Own home
_____ Rent
_____ Board
_____ Live (Parents)
_____ With (Relatives)
_____ Purchasing home

Number and age of dependents:
____
Relationship of dependents:
____
Business or occupations of father:
____
or Husband ____________

Interested in: Temporary work____ Full-time____ Part-time____ Saturday only____
Salary expected ____________________
Are you responsible for your entire support? _____ Others who are dependent on you for their support: Number _____ Ages ____________________
Nature of any physical defects ____________________
Recent illnesses ____________________
Date of last physical examination ____________________

EDUCATION	Circle grade completed	Name of School	Location	Major Subject	Year Graduated
Elementary	1 2 3 4 5 6 7 8				
High	1 2 3 4				
Business or Vocational	1 2 3 4				
College or University	1 2 3 4 5 6				
Night or Correspondence	1 2 3 4				

ASSIGNMENT SHEET #3

Give details of any other educational training ______________________________

____

What are your hobbies? ____

In case of illness or emergency, notify:

Name ____________________

Address ____________________

Relationship ____________________

Telephone ____________________

Why do you feel qualified for the position for which you are applying?

____

____

PREVIOUS EMPLOYMENT
(Last employment first)

From	To	Name & address of employer	Department-position duties-salary	Reason for Leaving
Month Year	Month Year			
Month Year	Month Year			
Month Year	Month Year			
Month Year	Month Year			

R - 61-H

ASSIGNMENT SHEET #3

PERSONAL REFERENCES

(Do not give names of relatives or former employers)

	Name	Address	Occupation
1.			
2.			
3.			

Do Not Write In Space Below

Interviewed by:

Personality ____________________
Attitude ____________________
Ambition and initiative ____________________

Other remarks

Calmness ____________________
Physical qualities ____________________
Intelligence ____________________
Leadership ____________________
Appearance and grooming ____________________
Work best suited for ____________________

APPLYING FOR A JOB
UNIT IV

ASSIGNMENT SHEET #4--WRITE A FOLLOW-UP LETTER AFTER AN INTERVIEW FOR A RESIDENTIAL WIRING JOB

Directions: Using the standards, points to be included, and the example, write a follow-up letter.

Make sure this letter meets the following standards:

1. Error free
2. Clean, neat, and arranged attractively
3. Free from spelling, punctuation, and grammatical errors
4. Sent within a day or two after the interview

Points to include in a follow-up letter

1. An expression of appreciation for the interviewer's time and interest
2. A summary of personal qualifications and interest in the position

(NOTE: Make this last bid for the job a prime example of your excellent work habits. Make the letter as clean, neat, and well worded as possible.)

Example:

Mr. John Jones
Personnel Director
Jones Electrical
Box 19
Anywhere, U.S.A. 77704

Dear Mr. Jones:

Thank you for interviewing me for the residential wiring job in your firm. I feel that working for Jones Electrical would be enjoyable and that I could do the residential wiring that the job requires. I hope that I will have the opportunity to prove my worth.

The application form you gave me is enclosed.

I will be available for work May 15. You may call me at my home after 3:30 p.m. The number is 377-3303.

Sincerely yours,

Pat L. Smith

encl.

APPLYING FOR A JOB
UNIT IV

NAME ____________________

TEST

1. Match the terms on the right to the correct definitions.

_____a. A brief typed summary of one's qualifications and experiences that is used in applying for a job

_____b. The extras provided by an employer such as paid vacations, sick leave, and insurance protection

_____c. Recognition received for outstanding achievement

_____d. The experience, education, and physical characteristics which suit a person to a job

_____e. Any vocational courses taken and skills one has learned in school or through work experience

_____f. The clubs, organizations, and social or church groups in which one participates

1. Awards
2. Extra-curricular activities
3. Fringe benefits
4. Qualifications
5. Resume
6. Vocational preparation

2. List four means of locating job openings.

a.

b.

c.

d.

3. List three methods of applying for a job.

a.

b.

c.

4. Select items of information that may be asked for on an application by placing an "X" in the appropriate blanks.

______a. Race

______b. Name and address

______c. Phone number

______d. Shoe size

______e. Age, height, weight

______f. Education

______g. Number of brothers and sisters

______h. Experience

______i. Next of kin

______j. Make and model of car

______k. Previous employers

______l. Reason for leaving last job

______m. Are you left or right handed

______n. Type of job for which one is applying

______o. References

5. Distinguish between employer and employee expectations by placing an "X" in front of the employer's expectations.

______a. Cooperation

______b. Honesty

______c. Initiative

______d. Salary

______e. Safe working conditions

______f. Training

______g. Willingness to learn

______h. Willingness to follow directions

______i. Introduction to co-workers

_____j. Dependability

_____k. Enthusiasm

_____l. Acceptance of criticism

_____m. Loyalty and respect

_____n. Full day's work for full day's pay

_____o. Notification of termination

6. Select personal attributes or attitudes that an employer looks for during a personal interview by placing an "X" in the appropriate blanks.

_____a. Alertness, quickness of mind

_____b. Long wavy hair

_____c. Dedication and dependability

_____d. Enthusiasm and interest

_____e. New car

_____f. Honesty and integrity

_____g. Desire to work

_____h. Beard

_____i. Flashy clothes

_____j. Desire to help others

_____k. Desire to improve one's self

7. Select examples of proper conduct during an interview by placing an "X" in the appropriate blanks.

_____a. Arrive five minutes late; gives the impression that you are busy

_____b. Sit and stand erect; do not lean against the wall, a chair, or the desk

_____c. Call interviewer by his or her first name

_____d. Answer questions completely

_____e. Put a hat or coat on the interviewer's desk ______f. Greet interviewer with a warm smile

______g. Sit down immediately upon entering the room

______h. Shake interviewer's hand firmly

______i. Be polite and courteous

______j. Use all of the cute slang expressions

______k. Be sincere and enthusiastic

______l. Thank the interviewer

______m. Chain smoke

______n. Speak well or not at all of former employers and associates

______o. Flatter the interviewer

______p. Leave promptly at completion of interview

8. Demonstrate the ability to:

a. Prepare a resume.

b. Write a letter of application for a residential wiring job.

c. Complete an application form for a job as a residential electrician.

d. Write a follow-up letter after an interview for a residential wiring job.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

APPLYING FOR A JOB
UNIT IV

ANSWERS TO TEST

1. a. 5
   b. 3
   c. 1
   d. 4
   e. 6
   f. 2

2. Any four of the following:
   a. Classified ads
   b. Employment offices
   c. Local labor union business office
   d. School officials
   e. Workers in residential wiring occupation

3. a. Letter
   b. Telephone
   c. In person

4. b, c, e, f, h, i, k, l, n, o

5. a, b, c, g, h, j, k, l, m, n, o

6. a, c, d, f, g, j, k

7. b, d, f, h, i, k, l, n, p

8. Evaluated to the satisfaction of the instructor